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Aviation Week

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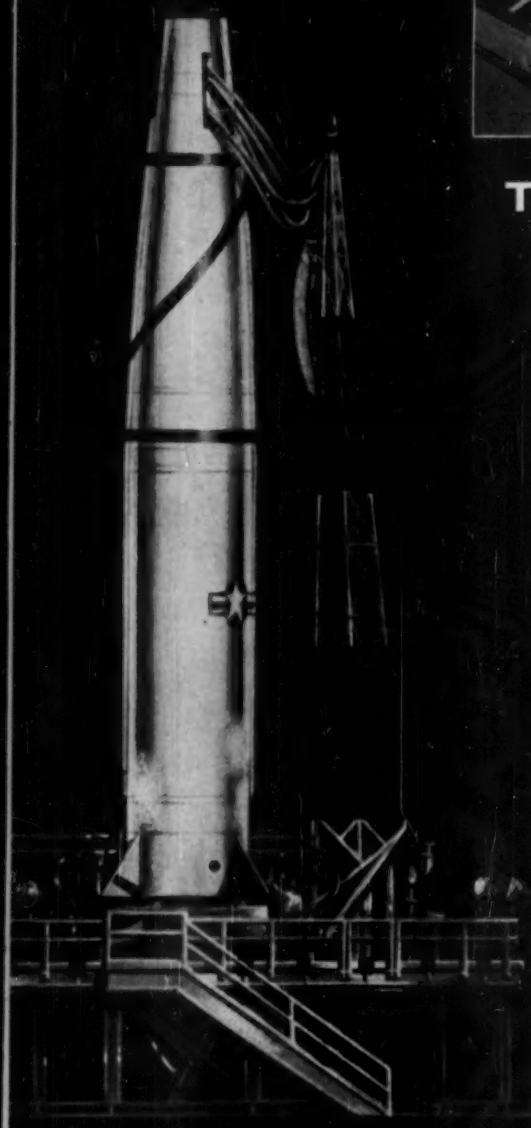

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Now rolling from assembly lines in the U.S.A. and being deployed by our ally, Great Britain, is the aggressor deterring, nuclear armed THOR missile. Exceptional reliability has been achieved in this IRBM missile through simplicity of design and dependability of components.

Vickers pumps were selected for the vital hydraulic system on the THOR because of their proven reliability record, based upon millions of flight hours in military and commercial aircraft. Vickers built components or complete auxiliary power systems are aboard nearly every missile built in America.

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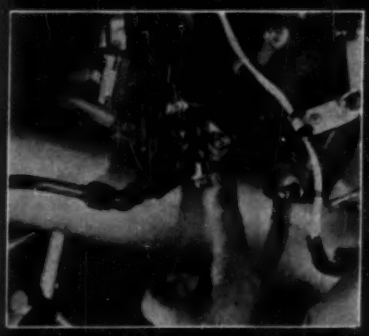

Vickers Main System Hydraulic Pump being installed on THOR

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This remarkable jetliner has the quietest cabin in aviation history. It can operate with ease from the small airports which the big, long range jets must overpass.

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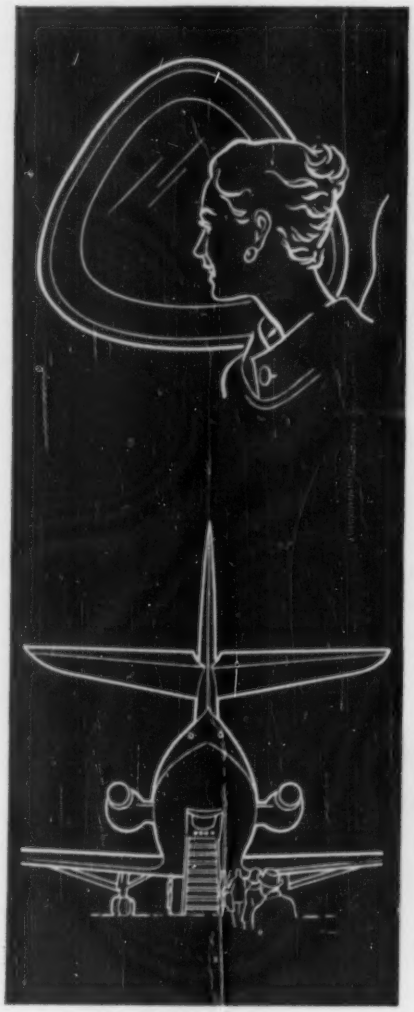
With the medium-range Caravelle and the long-range DC-8, Douglas is the only company in the world that can offer pure jet airliners ideally suited for airline routes from 200 to 5000 miles.



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AVIATION CALENDAR

May 9-11—31st Annual Meeting, Aerospace Medical Assn., Americana Hotel, Bal Harbour, Miami Beach, Fla.

May 9-11—1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego.

May 9-12—Semi-Annual Meeting and Astronautical Exposition, American Rocket Society, Ambassador Hotel, Los Angeles.

May 9-12—Summer Instrument-Automation Conference & Exhibit, Instrument Society of America, Civic Auditorium, San Francisco, Calif.

May 9-13—Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel and State Fair Park, Dallas, Tex.

May 9-13—Annual Conference, Society of Photographic Scientists and Engineers, Miramar Hotel, Los Angeles, Calif.

May 10-12—1960 Electronic Components Conference, Willard Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers' Professional Group on Component Parts; American Institute of Electrical Engineers; Electronic Industries Assn.; Western Electronic Manufacturers Assn.

May 11-14—16th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 15-18—Annual Convention and Business Meeting, American Assn. of Airport Executives, Waldorf-Astoria, New York.

May 16-20—Aviation Fire Safety Seminar, National Fire Protection Assn., Queen Elizabeth Hotel, Montreal, Canada.

May 18-20—National Meeting, Society for Experimental Stress Analysis, Hotel Severin, Indianapolis, Ind. Theme: Stress Analysis of Propulsion Systems.

May 22-29—Fourth Annual Reserve Navigation Competition, Ellington AFB., Tex.

May 23-25—12th Annual Meeting, German Society for Rocket Engineering and Space

(Continued on page 6)

AVIATION WEEK and Space Technology

May 2, 1960

Vol. 72, No. 18

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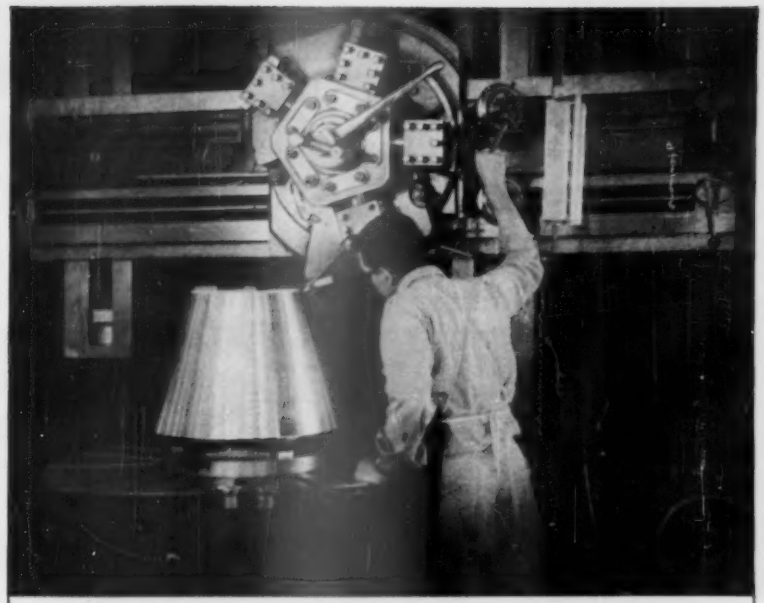

missile / AEROSPACE COMPONENTS BY LAVELLE

Sheet metal wall thickness is controlled as the outer surface of an aluminum alloy nose cone is machined to precision size on a boring mill at Lavelle. Part of the RVX Series re-entry vehicle structure, recovered after full ICBM range flight, the machined cone is typical of methods used by Lavelle to meet the varied requirements of the aerospace industry.

Shown between the nose cone structures above is a part of the Hawk missile system, a radar pedestal base magnesium weldment partially machined after assembly. Lavelle works with a wide range of metals and alloys to produce sheet metal components for missiles, electronic systems and ground support equipment to exacting specifications. Major companies rely on Lavelle for precision components required in missiles, space vehicles, jet engines and airframes.

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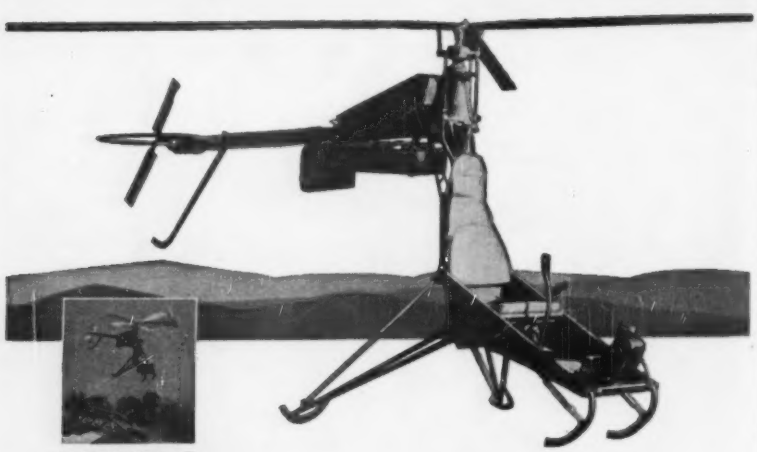

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AVIATION CALENDAR

(*Continued from page 5*)

Flight Research, Heidelberg, Germany.

May 23-25—1960 National Telemetering Conference, Miramar Hotel, Santa Monica, Calif. Sponsors: Instrument Society of America; American Rocket Society; American Institute of Electrical Engineers; Institute of the Aeronautical Sciences; Institute of Radio Engineers.

May 23-25—14th Annual Armed Forces Communication and Electronics Association Convention, Sheraton Park Hotel, Washington, D. C.

May 24-26—1960 Convention, American Society for Quality Control, San Francisco, Calif.

May 25-27—National Specialists Meeting on Guidance of Aerospace Vehicles, Institute of the Aeronautical Sciences, Hotel Somerset, Boston, Mass.

May 26-27—"Psychophysiological Aspects of Space Flight," symposium, Hilton Hotel, San Antonio, Tex. Sponsored by the School of Aviation Medicine, USAF Aero-Space Medical Center (ATC), and arranged by Southwest Research Institute. Unclassified, but by invitation.

May 27-30—12th Annual Wright Memorial Glider Meet. For information: Soaring Society of Dayton, Inc., Far Hills Branch, P. O. Box 581, Dayton 19, Ohio.

June 3-4—11th National Maintenance & Operations Meeting, Reading Aviation Service, Reading, Pa.

June 5-9—Semi-Annual Meeting and Aviation Conference, American Society of Mechanical Engineers, Statler Hilton Hotel, Dallas, Tex.

June 14-16—35th Meeting, Aviation Distributors and Manufacturers Assn., Queen Elizabeth Hotel, Montreal, Canada.

June 22-24—1960 Conference on Standards and Electronic Measurements, NBS Boulder Laboratories, Boulder, Colo. Cosponsors: Institute of Radio Engineers' Professional Group on Instrumentation; Radio Standards Laboratory, National Bureau of Standards; American Institute of Electrical Engineers' Instrumentation Division.

June 23-25—16th Annual Meeting, Institute of Navigation, U. S. Air Force Academy, Colorado Springs, Colo.

June 27-29—Fourth National Convention on Military Electronics, Institute of Radio Engineers, Sheraton-Park Hotel, Washington, D. C.

June 28-July 1—National Summer Meeting, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif.

Aug. 15-20—11th Annual Congress, International Astronautical Federation, Royal Institute of Technology, Stockholm.

Aug. 23-26—Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Sept. 5-11—1960 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 12-16—16th Annual General Meeting, IATA, Copenhagen, Denmark.

Sept. 12-16—Second International Congress, International Council of the Aeronautical Sciences, Zurich, Switzerland.

Sept. 21-25—National Convention and Aerospace Panorama, Air Force Assn., Civic Auditorium and Brooks Hall, San Francisco, Calif.

"One of the LOWEST OPERATING COSTS *ever experienced with any airplane in commercial air transportation."*

Leslie O. Barnes, President, said in announcing Allegheny Airlines' decision to buy five Napier Eland jet-powered Convair 540s after the severest kind of test—more than six months of daily airline operation, under lease, on the Allegheny system.

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Napier Engines, Inc., is proud to be an important part of Allegheny's program to bring the best in local air commuter service to more than 24,000,000 people in thirteen states of the Middle Atlantic area and New England.

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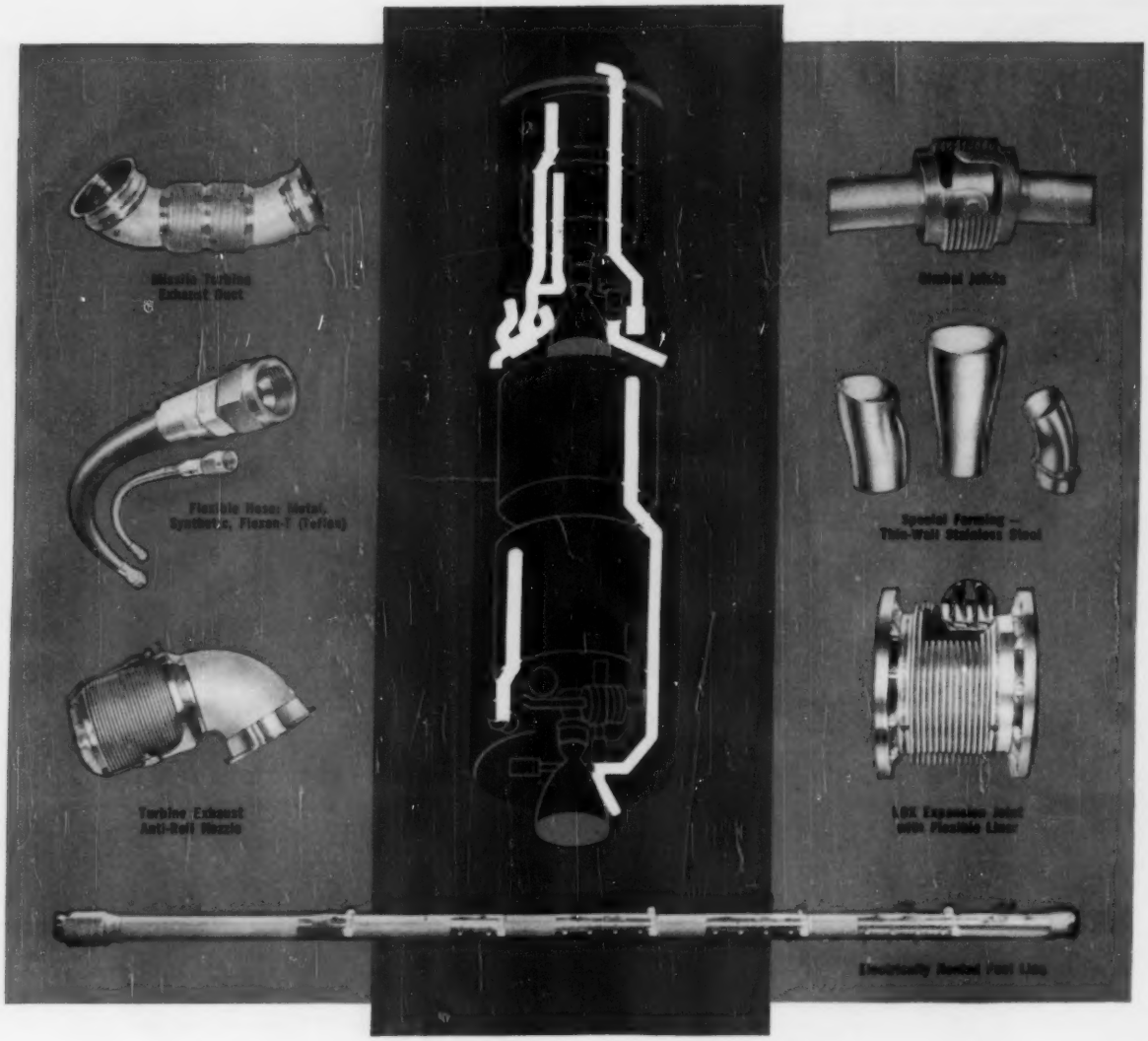

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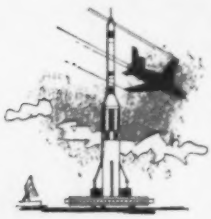

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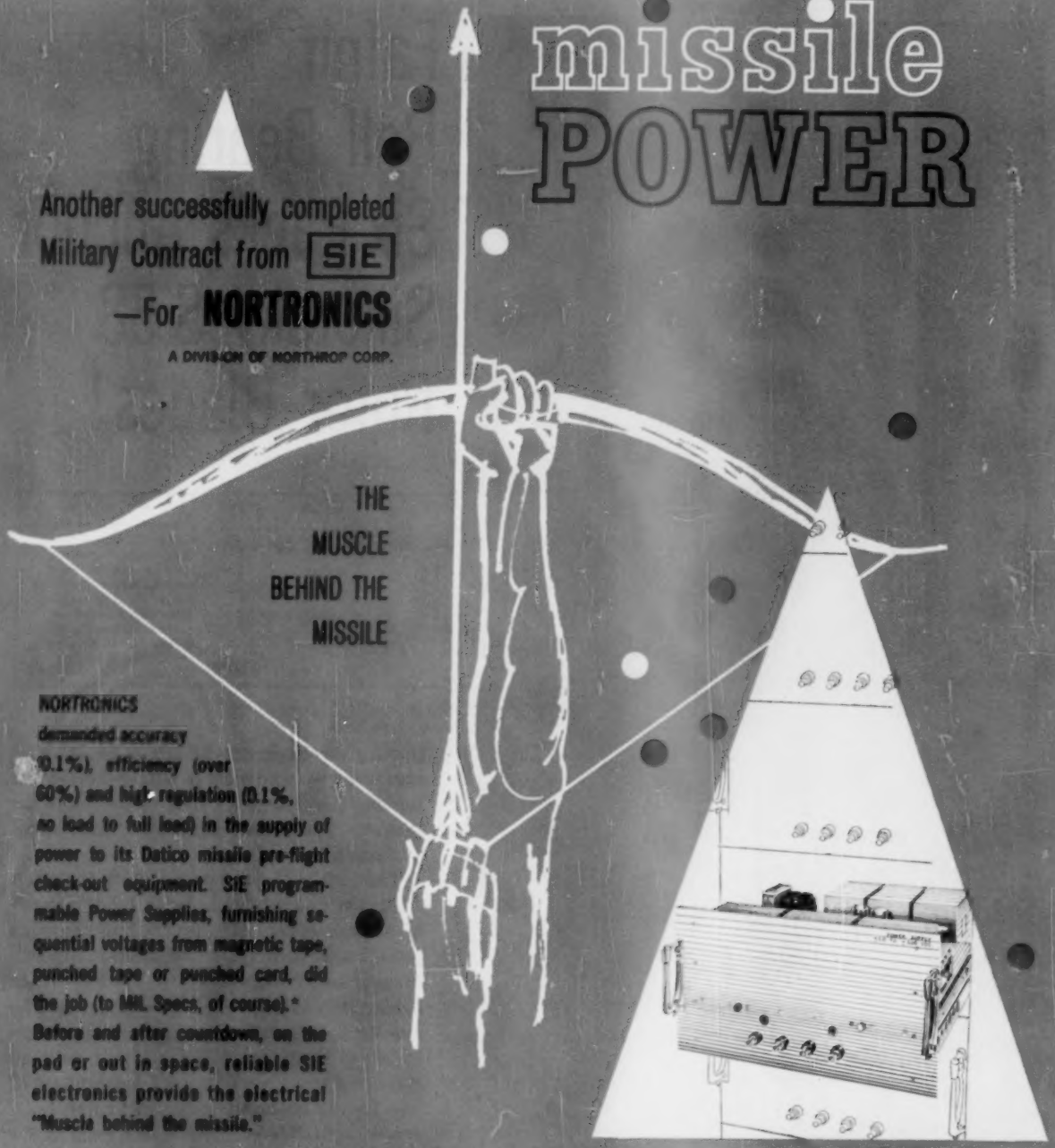

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NORTRONICS demanded accuracy (0.1%), efficiency (over 60%) and high regulation (0.1%, no load to full load) in the supply of power to its Datico missile pre-flight check-out equipment. SIE programmable Power Supplies, furnishing sequential voltages from magnetic tape, punched tape or punched card, did the job (to Mil. Specs, of course).* Before and after countdown, on the pad or out in space, reliable SIE electronics provide the electrical "Muscle behind the missile."

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More than 60% efficiency
Better than 0.1% regulation
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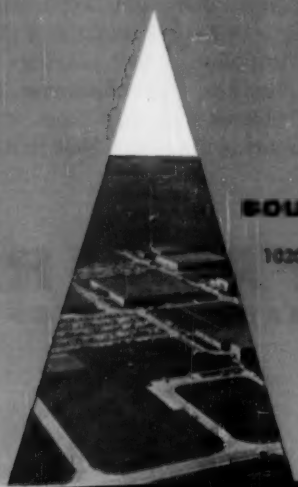
PS-23 — 1 to 500 vdc in 1 volt steps, 1 amp
PS-24 — 0 to 99.9 vdc in 0.1 volt steps, 1.5 amps



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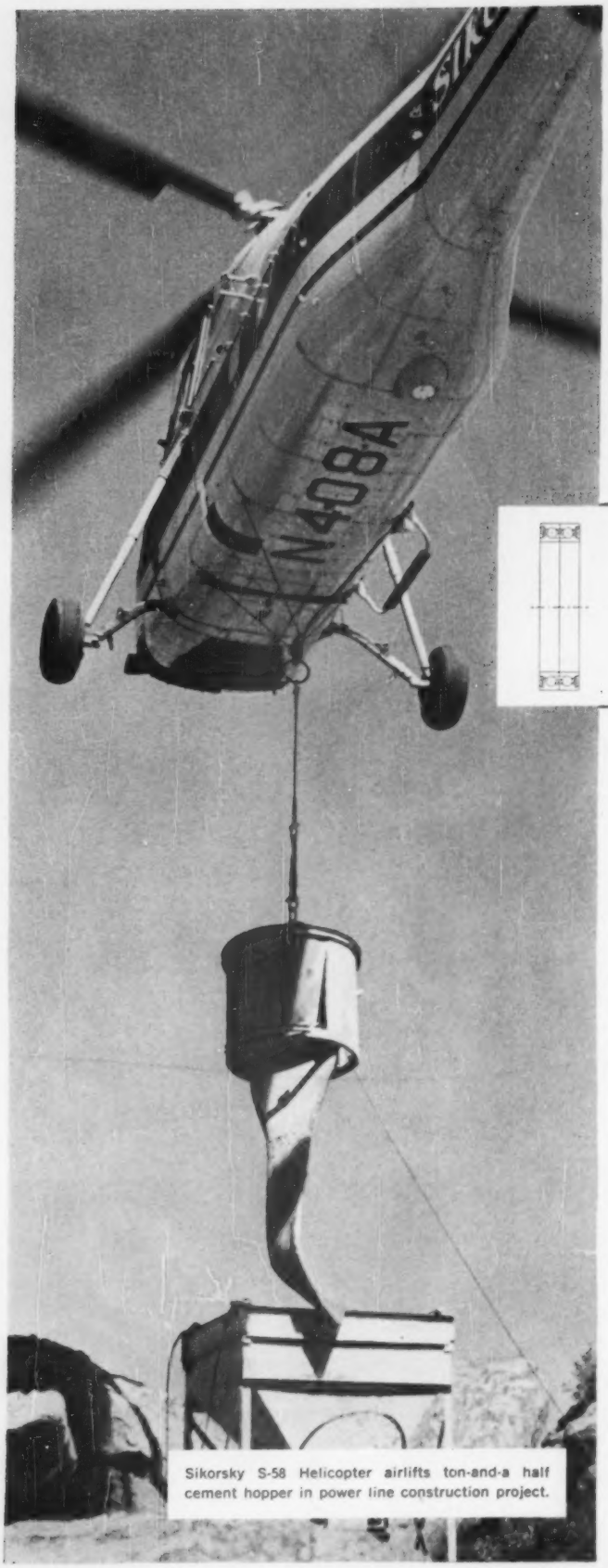
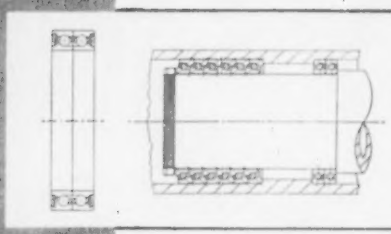


Sikorsky S-58 Helicopter airlifts ton-and-a half cement hopper in power line construction project.



A tandem set of six Fafnir WI Type counterbored ball bearings plus a duplex pair absorb unusual thrust loads in S-58 main rotor blade retention section. At left: Fafnir Y-PWI Series Duplex Helicopter Bearings.

During development of the S-58, Fafnir engineers worked closely with Sikorsky on bearing requirements. The blade retention sections presented especially interesting problems.

The entire load encountered in pitch control of the rotating blades (the "wings" of the helicopter) falls on the ball bearings used in the blade retention section. Smooth instantaneous response is a must — since blade pitch is what steers the aircraft. The answer: A tandem set of six Fafnir counterbored bearings, plus a duplex pair, in the main rotor section and a tandem set of five Fafnir bearings in the tail rotor.

Fafnir ball bearings are also used in the tail drive shaft, main shaft, and other critical locations. Job-right applications such as these have helped establish Fafnir as a leading supplier of ball bearings for aircraft, jet engines, and accessories. For help with problems *you* may have, write The Fafnir Bearing Company, New Britain, Connecticut.

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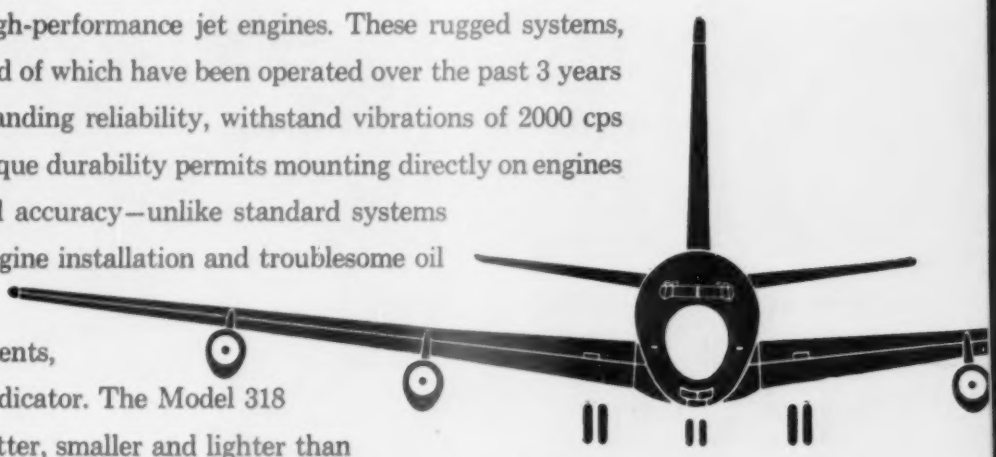
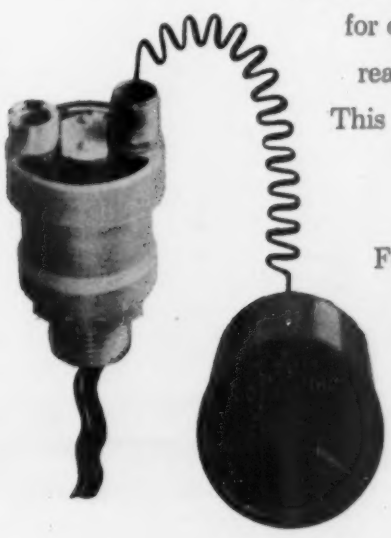
Edison's pressure indicating system provides unique protection for today's high-performance jet engines. These rugged systems, several thousand of which have been operated over the past 3 years with outstanding reliability, withstand vibrations of 2000 cps at 20 g's. This unique durability permits mounting directly on engines for greater response, and accuracy—unlike standard systems which require off-engine installation and troublesome oil or fuel lines. The system consists of two components, transmitter and indicator. The Model 318 frictionless transmitter, smaller and lighter than ever before, meets requirements of new specification MIL-T-26638. Hermetically sealed indicators, available in 1½" and 2", require less than 0.6 watts for operation. A 2" model is integrally lighted for utmost readability in compliance with MIL-L-25467A (ASG). This versatile indicating system—originally designed for oil pressure measurement—can also be used to indicate fuel pressure, BMEP, as well as torque. For the full story on aviation's most reliable pressure indicating system, write for publication 3049.





Standard hermetically sealed indicator, available in 1½" and 2". Model 296, a 2" indicator, is integrally lighted: in daylight, numerals and pointer are white and at night red. When power is off, pointer will move off-scale below zero.

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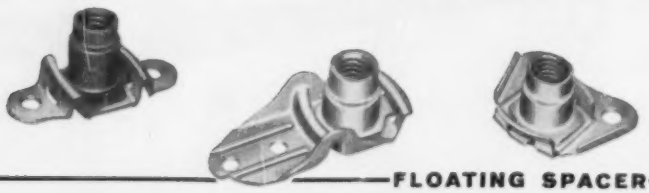
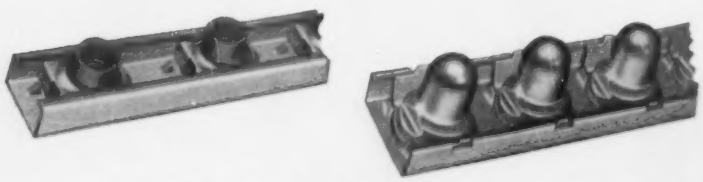


FLOATING SPACER

SELF-SEALING DOME



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Fixed anchor, floating anchor, spacer . . . whatever your requirement in this class of locknut, SPS provides a Nutt-Shel design to meet it.

Nutt-Shel lightweight locknuts are part of SPS's complete line of aircraft/missile fasteners, which includes all AN, MS and NAS types—bolts and locknuts—plus SPS special high-performance types. Among the latter you can specify bolt/locknut combinations for temperatures to 1600°F., tensiles to 260,000 psi and shear strengths to 156,000 psi. And looking to tomorrow, the SPS laboratories for advanced research are already testing prototypes of fasteners offering even higher levels of performance and mechanical reliability.

For more information, write SPS—manufacturer of precision threaded fasteners and allied products in many metals, including titanium. Bulletin giving complete data on Nutt-Shel products is available on request.

Specifications—Nutt-Shel Lightweight Locknuts

Materials
Alloy Steel Nuts: Threaded element per AMS 6350; Corrosion-Resisting Steel Nuts: Threaded element per AMS 5525 (A-286).

Performance
Meet or exceed AN-N-10 and/or MIL-N-25027 (ASG). Alloy steel nuts serviceable to 550°F., corrosion-resisting nuts to 900°F.

Mounting Styles
Standard rivet holes, dimpled rivet holes for flush mounting, or projection weld dimples.

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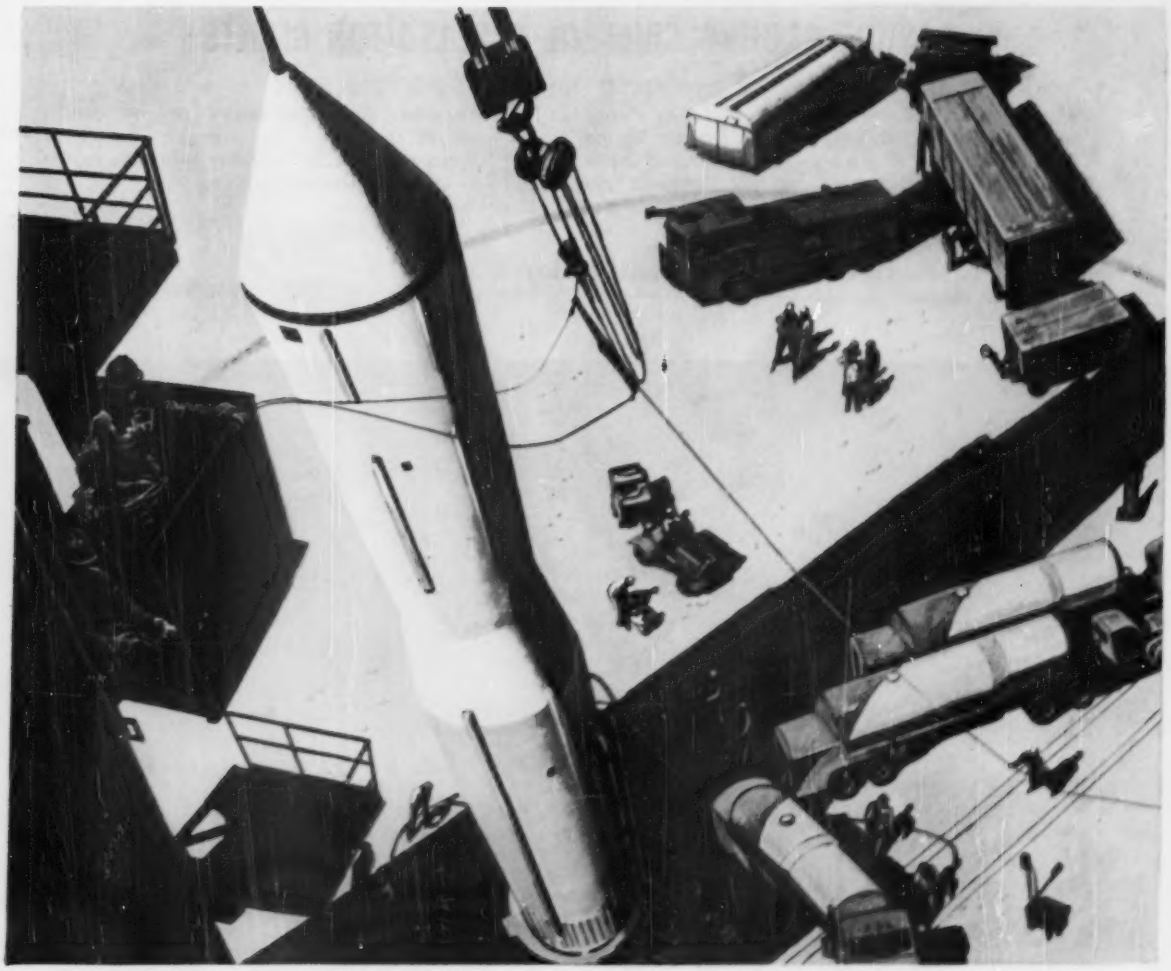

SEARING HEAT, FRIGID COLD TORTURE MISSILE BEARINGS

When a rocket fires, each component must *be* right, *work* right, the *first* time—and operating conditions are extreme! For example, liquid oxygen sends bearing temperatures plunging to hundreds of degrees below zero . . . while engine heat roasts bearings at a near-thousand degrees. Elsewhere, incredibly precise systems move surely on bearings with millionths-of-an-inch tolerances. In these critical applications you'll find Bower Roller Bearings!

On the ground, Bower Roller Bearings keep trucks, equipment and gantries rolling under the heavy loads essential to the missile's launching.

Bower, a major supplier of bearings for missiles and aircraft, also serves many other industries—automotive, construction machinery, machine tool and farm equipment, to name a few. You'll find bearings for most every field in Bower's full line of tapered, cylindrical and journal roller bearings.

BOWER ROLLER BEARINGS

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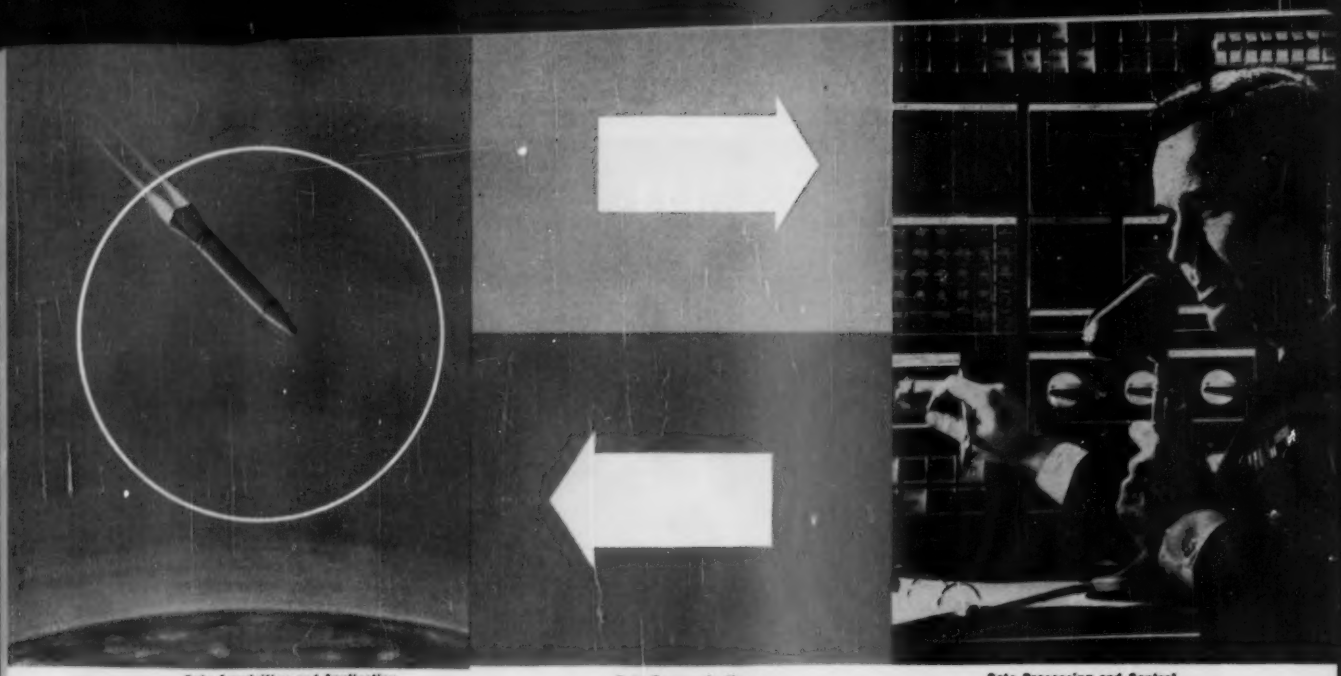

Data Acquisition and Application | Data Communication | Data Processing and Control

The 3 elements of an automated military system: all logical capabilities of IBM

IBM's Federal Systems Division has a unique three-way capability. Because of it, the Division can effectively handle study and development contracts of total defense systems—or assume total system management responsibility. It can originate the systems concept and carry it all the way to implementation.

In data acquisition and application subsystems—IBM has the facilities and manpower to develop and furnish the sensors, displays, and other devices for man-to-application, and machine-to-application communications. Also, to develop automatic sensors, sensor control, automatic dissemination facilities and displays required to direct proper and efficient functioning of the entire system.

In data communication subsystems—With capabilities and experience in IBM Tele-processing*, Federal Systems has the knowledge and facilities needed to design and develop complete networks to meet systems requirements. This includes, for example, data communication subsystems with message switching functions and terminal instrumentation. Message processing equipment, inquiry stations, and code modulation-demodulation equipment are already under development in the Division's laboratories.

In data processing and control subsystems—Engineers and scientists at the Federal Systems Division can draw on a vast IBM background in data processing to develop new and advanced systems and programming concepts. They can draw on existing equipment, or utilize widespread manufacturing facilities to meet both the engineering and production requirements of totally new instrumentation.

The three elements of a military system are all logical capabilities of IBM's Federal Systems Division—for development *and* systems management.

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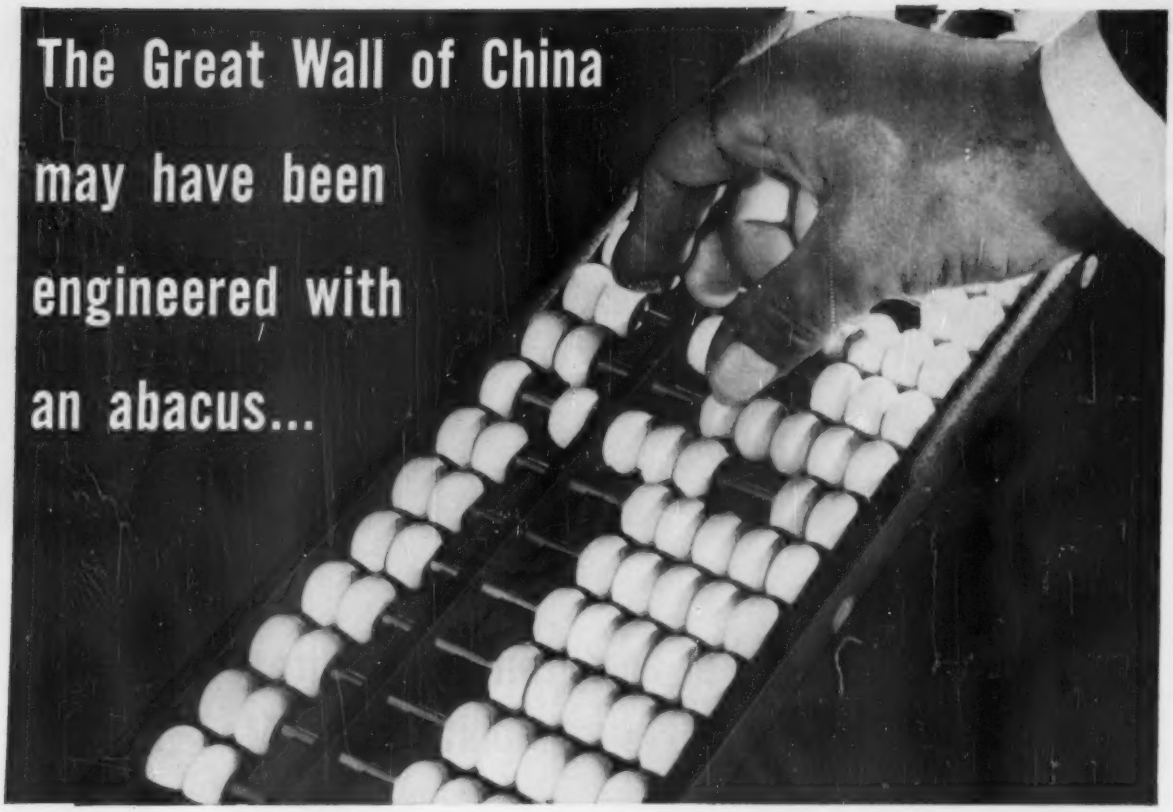
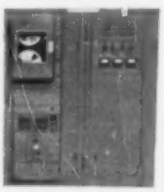


. . . but Space Age defenses require the speed and reliability of electronic data handling, a proved capability of Cubic Corporation instrumentation at the major missile test centers of the nation.

DH-3: Cubic SECOR, designated the AN/FRQ-10 by the Air Force, is a multi-station missile-tracking system installed on the Eglin Gulf Test Range. The precision distance measurements made by SECOR are digitally coded and magnetically recorded in the Cubic DH-3.



DH-10: On the Pacific Missile Range, data is fed from a number of outlying radars to a central computing facility for processing. At each radar, a Cubic DH-10 interrogates the radar and prepares appropriate digital words for transmission and magnetic recording.

DH-4: To facilitate subsequent computer processing, the DH-3 data is coded in binary form. The DH-4 data playback translator converts the binary data to decimal form, provides an illuminated display and prints out decimal data on paper tape or punched cards.

DH-14: The Cubic DH-14 Digital Multiplexing Synchronizer is used at a Pacific Missile Range central data-processing facility. It is fed the outputs of one to six DH-10 / data-link combinations and multiplexes them, in real time, into a large-scale computer. DH-14 output: 36 bits in parallel.

DH-8: Cubic COTAR an omnidirectional angle measuring system, generates a pair of direction cosines. On Ascension Island, a COTAR is combined with Cubic distance-measuring equipment to provide complete position information. The DH-8 performs the necessary analog computation to convert this information to x-y-z form.

DATA HANDLING

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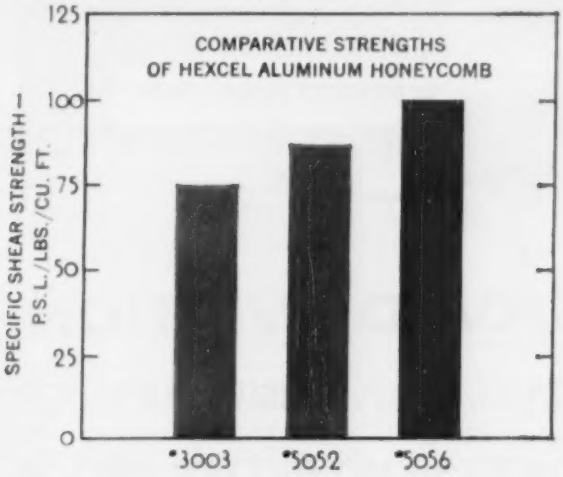
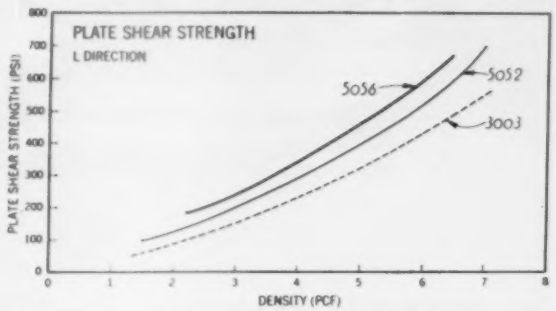


Hexcel 5056 honeycomb is the result of four years' research and study of more than 100 materials, including 10 aluminum alloys, and represents the first major improvement in aluminum honeycomb since 1954, when Hexcel introduced its 5052 alloy honeycomb to the industry. 5056 alloy contains the same metals as Hexcel's 5052 and 3003, with a significant increase in magnesium content. Current tests indicate that 5056 has very nearly the highest strength-to-weight ratio of any aluminum honeycomb ever made, but without the corrosion problems usually associated with high-strength aluminum alloys. New 5056 honeycomb offers an immediate solution to design problems of weight and strength in the aircraft and missile fields, as well as applications in electronics, construction, lighting and packaging.



In comparison with 5052 alloy, 5056 shows an improvement in bare compressive properties of approximately 25% which is 250% of specification minimums. Shear strengths are at least 20% above 5052 and 50 to 100% above specification minimums. 5056 cell sizes are ⅛" to ⅜"; foil gauges .001" and .002". For detailed test results and complete data on Hexcel's 5056 honeycomb, write Dept. 5-E.

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COVER: Douglas DC-8 jet transports on line at Long Beach, Calif.

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Convair 880 shrinks weight with new type B.F.Goodrich zippered panels

The target of the designers of the Convair 880 was to make the ship the fastest jet airliner. Thus these zippered rubber panels, used in both fore and aft cargo sections, had to exceed existing types in strength/weight ratio.

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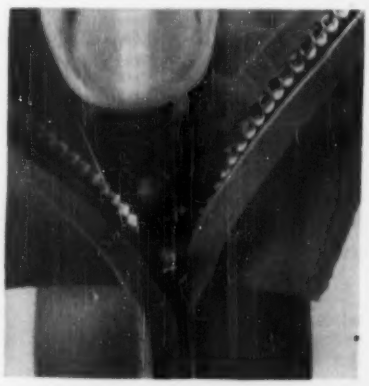
Some 25 of these panels are used in the 880 to seal the compartments against air or fuel vapor, yet permit instant access to concealed equipment. Color is white to provide good light reflection; cleaning is easy.

B.F.Goodrich has outstanding experience in fabricating zippered panels for sealing...interior compartments, air ducts, access ports, and other areas. For technical assistance, check with *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept.* AW-5A, *Akron, Ohio.*

The B.F.G. Pressure Sealing Zipper is designed with a precision fit of the rubber lips to make a tight seal, even around curves and corners. Opens quickly, like an ordinary zipper—yet seals out liquids, gas, air and dirt.



B.F.Goodrich aviation products

EDITORIAL

Airlines at the Crossroads

U.S. airlines recorded an historic achievement during 1959 with the first successful large-scale operations of turbojet-powered transports. Last year, some 66 Boeing 707s and 18 Douglas DC-8s flew approximately three billion revenue passenger miles in domestic trunkline service and another billion revenue passenger miles in international service. All of this was completed without a single passenger fatality.

Despite earlier British airline operations with early-model Comets, the debut of the Boeing and Douglas jets was really the first major fleet-wide operation of jet transports outside the iron curtain and is truly an historic milestone in man's long struggle to compress time and distance to suit his needs. The airlines that operated these planes and the many manufacturers who contributed to their design and construction should take great pride in this achievement. Air traffic control personnel of the Federal Aviation Agency, who successfully integrated jet operations into an already badly overstrained traffic control situation, also deserve special notice for their contribution to the initial operational success of the jet transports.

However, in the period immediately following this great feat, the airlines are coming to what may be another historic crossroad in their economic development. The advent of the jet era imposed severe financing requirements to make fleet-wide purchases, and now that these aircraft are fully operational, they face tremendous earning requirements not only to retire these debts but also to lay a sound financial foundation for future airline growth.

The jets' great potential capacity to earn airline profits depends upon considerably more precise operational capabilities, much greater traffic growth and much more efficient airline management than the piston era required. It also requires a new, and much more swiftly responsive, regulatory philosophy on the part of the Civil Aeronautics Board. It is rather ridiculous to have an industry that offers 600 mph. services, and already can see a jump to 2,000 mph. supersonic transports on its technical horizon, to be regulated by a federal agency that moves at the pace of a goose quill pen.

The Federal Aviation Agency under the leadership of Elwood R. "Pete" Quesada has proved remarkably responsive to the technical requirements of the jet transport era and has shown by its actions during the past 18 months that a federal agency does not necessarily have to move at an unbearably slow and befuddled pace against the technical grain of the aviation industry. It is high time the Civil Aeronautics Board geared its pace and the caliber of its operations to match similar requirements in the economic field.

Over the past five years, under a variety of chairmen, the Board has demonstrated little indication that it could maintain a pace anywhere nearly commensurate with that of the industry it is required to regulate. It is obvious from the personnel of recent Boards that the agglomeration of lame duck senators from both parties, faithful political hacks using the Board as a rest period on their climb to the federal bench, West Point classmates of the President and Boy Scout leaders will not do the job. In the past decade, the Board has had only a very few members who had either a rudimentary knowledge of the industry they were required to regulate or the energy and interest to devote themselves fully to their regulatory task.

Typical of how the industry pace is hopelessly outrunning the ability of the Board to maintain any realistic touch with its problems is the General Passenger Fare Investigation. Demands for fare adjustments were intensified over two years ago by an economic crisis confronting the airlines some two years after the fare investigation was first begun. However, the investigation is still dragging along in the Board without any semblance of a decision, although many promises of "imminent action" have been whispered.

In the meantime, the industry has passed through its original financial crisis and has emerged into another engendered by the tremendous capacity plus the velocity factor of the jet transports. At least one airline already has thrown this problem back in the teeth of the Board with a request for a return to subsidy.

It would seem apparent from the present highly developed air transport system in this country that the regulatory philosophy of the Board also requires some modification to fit the current environment rather than to plod stolidly along the well-worn grooves of precedent aimed at the long-gone initial development problems of the air transport industry.

This philosophy might well be broadened from its present narrow concept of regulation down to the last detail to a concept that still provided the public with basic safeguards but allowed considerably more scope for airline management to exercise its ingenuity. This change is particularly needed in the area of fares. Here, the Board must certainly provide the public with protection against excessively high rates and give the industry some bulwark against ruinous rate wars. But, within these limits considerably more flexibility could be cranked into the system to permit airline management more latitude and speed in solving its own problems.

The jet transport era has brought the airline industry past a major technical milestone and face to face with the economic crossroads of its era of financial maturity. It will require the best efforts of individual airline managements supported by a more flexible regulatory philosophy and more responsive techniques in applying this philosophy by the Civil Aeronautics Board to realize the full potential that lies in the future for the airline industry and the air traveling public. —Robert Hotz

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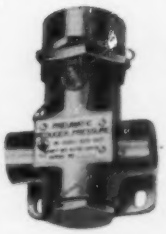
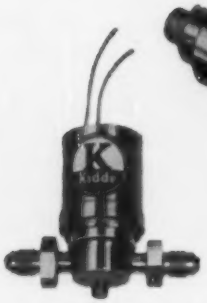


Semi-miniature pressure reducer. Inlet operating pressure 3000 psi. Outlet pressure range 300 to 400 psi. Temperature range minus 65°F. to plus 160°F. It provides intermittent service to 200°F.



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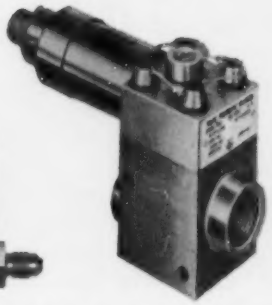

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WHO'S WHERE

In the Front Office

Dr. Harrison Brown, professor of geochemistry at California Institute of Technology, elected a director of Hycon Mfg. Co., Pasadena, Calif., and also named special scientific assistant to Trevor Gardner, president.

Richard E. Krafve, president, Raytheon Co., Boston, Mass., succeeding **Charles F. Adams,** now board chairman.

Harry Fante, a director, Aero Design & Engineering Co., Bethany, Okla., a subsidiary of Rockwell-Standard Corp. Mr. Fante is a director and vice president of Rockwell-Standard.

John H. Hutchings, a director, Eitel-McCullough, Inc., San Carlos, Calif. Mr. Hutchings is president of National Electronics, Inc., a subsidiary of Eimac.

Arthur P. Jacob, board chairman, Pacific Automation Products, Inc., Glendale, Calif.

Joseph F. Griffin, a director, Airpax Electronics, Inc., Fort Lauderdale, Fla. Mr. Griffin continues as divisional manager of the Seminole Division (Fort Lauderdale) plant. Also: **Dr. David A. Robinson,** chief engineer of Airpax, elected a vice president.

Joseph Rosener, Jr., president, and **Dr. Rolf D. Buhler,** vice president, Plasmadyne Corp., Santa Ana, Calif., a subsidiary of Giannini Scientific Corp.

Henry H. Michaels, Jr., president, PRD Electronics, Inc., Brooklyn, N. Y., succeeding **Dr. Ernst Weber,** president of Polytechnic Institute of Brooklyn, who will continue with PRD as a consultant.

John F. Thurston, vice president for special projects, General Dynamics Corp., New York, N. Y. **Raymond B. Carey, Jr.,** succeeds Mr. Thurston as division general manager of the corporation's Electro Dynamic Division, Bayonne, N. J.

George P. Hitchings, vice president-economic research, American Airlines, Inc.

Robert R. Smyth, executive vice president, and **Jon B. Jolly,** vice president, Power Sources, Inc., Burlington, Mass., a subsidiary of Technical Operations, Inc. Also: **Joseph Lima,** manager-manufacturing; **Anthony DeProfio,** production manager.

Southern Airways, Inc., has announced the appointment of the following as assistant vice presidents: **George F. Attwood,** properties; **J. K. Courtenay,** research and planning; **George M. Gross,** maintenance and engineering; **W. Bayne Grubb,** flight operations.

Selmer J. Ronnie, director of the Interline Reservations Procedures Office, Air Traffic Conference of America, a division of the Air Transport Assn., Washington.

Lt. Col. Donald V. Mayer, chief of Advanced Systems Division, Electronic Systems Center, Air Materiel Command, Bedford, Mass.

The following officers have been transferred from Navy's Bureau of Weapons to detached duty at the National Aeronautics and Space Administration, Washington, D. C.: **Cdr. William Schubert** assigned as chief for Centaur class vehicles; **Lt. Cdr. Albert J. Kelley** assigned as project manager for Agena class vehicles.

(Continued on page 189)

INDUSTRY OBSERVER

► Early Midas infrared early warning satellite vehicles will weigh about 5,000 lb. in orbit. Later models, which will be sent to higher altitude orbits, will weigh only about 3,000 lb., including a 1,000 lb. payload.

► **First test launching of the Samos electronic and optical reconnaissance satellite is now scheduled for the last quarter of this year from Pt. Arguello, Calif. Launching has been rescheduled because of several months' slippage in launch pad preparation.**

► Dyna-Soar boost glider is expected to cost about $638 million through 1966 for research and development vehicles and tests and evaluation. If the program moves successfully, about $300 million in procurement funds also would be put into the project through 1965, making a total of around $800 million.

► **Saturn flight research program costs for Fiscal 1961 include $57.5 million for development and fabrication of the 1.5-million-lb. thrust first stages; $42.3 million for similar work on upper stages; $12.8 million for guidance, controls and instrumentation; $9.7 million on ground service equipment and $12 million for direct material.**

► Presentation of the development plan for the new Tactical Air Command STOL low-level attack aircraft (AW Mar. 14, p. 29) was begun last week in the Pentagon by ARDC and TAC officials. These presentations to the Air Staff, the Weapons Board and the Air Council are expected to be completed in two weeks. Design competition would follow shortly.

► **General acceptance of the new variable sweep wing research information published by National Aeronautics and Space Administration's Langley Laboratory (AW Apr. 4, p. 32) is growing within the airframe industry. Several companies have conducted their own wind tunnel investigations of aircraft with this type of variable geometry, and their early skepticism of the concept has been largely overcome.**

► Advanced Research Projects Agency, Air Force's Wright Air Development Division and other top military contracting agencies are reportedly being flooded by unsolicited proposals from both within and outside the industry suggesting means of deactivating hostile or snooping satellites. Proposed plans include various proposals for physically damaging or destroying sensitive electronic gear by heat, radiation and impact with foreign bodies.

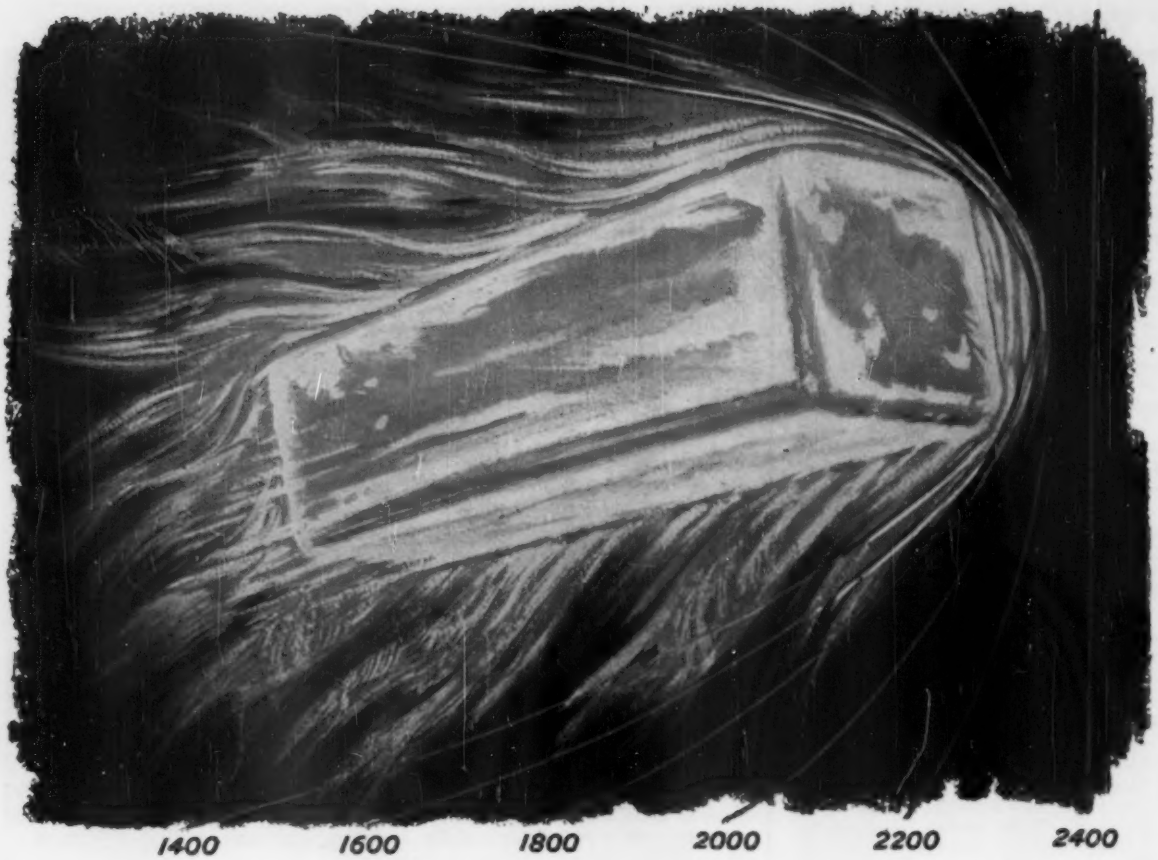
► **First stage of the Polaris fleet ballistic missile is ignited by an accelerometer-type system after the missile is launched by compressed air. Igniter system senses when the missile is reaching the peak of its compressed-air launch trajectory and fires the first stage engine.**

► Kaman Aircraft Corp. is nearing completion of development of an all-glass-fiber helicopter rotor blade. Kaman believes it has solved the problem of load orientation of the fibers for structural strength which has been a problem in previous attempts by various companies to develop such blades. A successful glass fiber blade would offer weight savings and reduction in manufacturing costs.

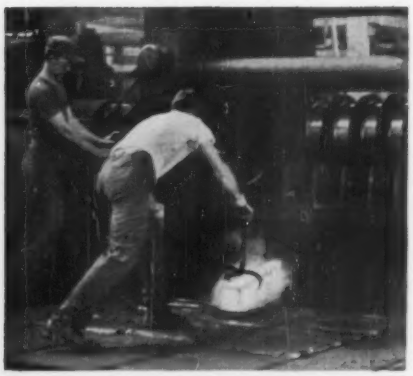
► **Australian evaluation team plans to visit Northrop's Norair Divison in July. Northrop has proposed its Rapiere system—an N-156 equipped with a Hughes Taran fire control system and Nord air-to-air and air-to-surface missiles, giving the aircraft an all-weather attack capability. Both Nord missiles probably are versions of the 5103.**

► First Air Force unit to be equipped with nuclear-tipped versions of the Martin Bullpup air-to-ground missile will be an F-100 unit at Cannon AFB, N. M. Range of the Bullpup, originally developed by Navy and Martin, is 50,000 ft. for both nuclear and non-nuclear versions.

► **Japan plans to purchase over 24,000 Mighty Mouse air-to-air rockets and approximately 60 Sidewinder air-to-air missiles from the U. S. during Fiscal 1960 under reimbursable assistance programs.**



Bending the Heat Barrier



Specialized mill equipment is available at HAYNES STELLITE for rolling high-temperature alloys into a variety of shapes and sizes. Bar (above) is being produced on a 24-inch mill.

High strength plus resistance to oxidation, creep, thermal shock, and fatigue—are some of the properties that have helped to push the heat barrier back over the past 15 years. These are the properties found in HAYNES high-temperature alloys. Properties that make these alloys very useful in the 1000 to 2000+ deg. F. range.

Typical uses? The really hot spots in jet aircraft, ramjets, and missiles are some. Furnace components, heat-treating equipment, kiln liners are others. In fact, any part where long service life under severe high-temperature conditions is essential.

There are 12 HAYNES high-temperature alloys—available immediately in convenient forms that can be readily fabricated. For information on properties and prices, write for descriptive literature.

HAYNES
ALLOYS

HAYNES STELLITE COMPANY
Division of Union Carbide Corporation
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Washington Roundup

Navy Carrier Fight

Navy plans a full-scale fight to push its Fiscal 1961 budget request for a conventionally-powered aircraft carrier through Congress this year. The carrier ran into early trouble with the House Appropriations Committee led by Rep. Clarence Cannon. Navy will lobby hard for House approval and will continue the fight in the Senate.

Senate pressure probably will be heavy for the nuclear-powered carrier Navy abandoned in the face of Administration budget ceilings. Conventional carrier was requested because it would cost $130 million less than a nuclear ship. Last year, the Senate ignored a similar decision and pushed through $35 million for nuclear carrier long lead-time items.

Navy will try to steer the Senate toward approval of a conventional carrier. Since the decision has been made in favor of this cheaper ship, appropriation of money for a nuclear ship would serve to delay work on a conventional carrier another year.

Missile Management

Air Force hopes to blunt congressional criticism of its missile program management this week when it formally unveils its divorce plan for Space Technology Laboratories (AW Mar. 7, p. 32). USAF officials are scheduled to tell the House Military Operations Subcommittee headed by Rep. Chet Holifield what the Air Force is doing about changes recommended by the House group last year. Nonprofit status was urged for STL.

USAF plans to establish a new management firm to gradually take over STL's current technical management functions. This follows recommendations of USAF's Millikan committee. New nonprofit corporation is expected to draw on the STL staff for its initial personnel.

This move counters long-standing congressional and industry criticism of STL's inside role in USAF missile programs. It also permits Thompson Ramo Wooldridge to reintegrate STL into its corporate pattern. STL will be able to bid for missile and space business as a conventional contractor.

Defense Department has back-tracked on proposed authority to censor company advertising after contents of a proposed directive on advertising became public (AW Apr. 4, p. 25). Directive would have given Assistant Defense Secretary Murray Snyder authority to ban ads dealing with such issues as the relationship of specific weapon systems to military policy and the economic impact of military contracts.

Snyder said the directive was proposed in response to recommendations of the House Armed Services Investigating Subcommittee under Rep. Edward Hebert. Hebert group asked for curbs on controversial type of advertising that appeared during the Nike Bomarc fight last year. Snyder said new rules will not go beyond Hebert's recommendations or abridge free speech rights. Snyder and Defense General Counsel J. Vincent Burke, Jr., met last week to take a fresh look at the advertising issue.

NASA Policy Change

Industry is rapidly adopting lobbying tactics for NASA competition similar to those developed in the battle for defense contracts. Companies with reputations for good technical performance once hoped NASA would award contracts solely on technical and cost considerations. Now they say they must do some political and economic lobbying to stay competitive in technical competitions.

Military services have long been accused of paying too much attention to broadening bases of supply and to helping contractors in need of business. Now industry feels NASA has begun to play this "old Pentagon game."

NASA has abandoned its original practice of having source selection boards pick tentative winners for Administrator T. Keith Glennan's approval. This move stems from congressional criticism of the Mercury capsule and F-1 engine contracts awarded just after NASA was created. Boards now evaluate each proposal in a competition, leave the selection to Glennan.

Soviet Bilateral

State Department is proposing a July 18 meeting in Washington to begin negotiations of an air transport bilateral with the Soviet Union. Russians said they were ready to start immediately when they asked for negotiations last month. They did not mention a location.

Commitments for bilateral discussions with other nations will preclude Soviet talks before July. U.S. and Philippine delegations opened negotiations in Washington last week on a new pact to replace the bilateral which expired Mar. 3.

There is no prospect of congressional action on the Commerce Department national transportation study this session. It will await completion of a Senate Commerce Committee survey of national transportation policy under staff direction of Maj. Gen. John P. Doyle (ret.), former Air Force director of transportation. Senate report is due Jan. 31.

—Washington Staff

Trunklines Gear for Competitive Battle

Carriers report poor results for first quarter; increased capacity impact should be clear by autumn.

By L. L. Doty

Washington—Domestic trunkline carriers, jolted in March by severe weather and a rash of widely-publicized accidents which combined to create a drastic traffic slump, are now gearing for a competitive battle that is expected to change the financial complexion of the entire industry.

With an increasing number of trunklines reporting net losses for the first quarter of 1960 and sharp declines in load factors, major industry leaders already are calling for a rearrangement of routes as a means of averting federal subsidies and enabling carriers to operate at a profit. At least one top industry official has warned that the need for some mergers will become palpably evident late this summer as competitive pressure tightens.

Although the industry reported a 9% increase in revenue passenger miles for the first quarter, the poor showing in March—when total traffic tumbled from an average monthly increase of 14% during the past 15 months to a 1% decline—took deep cuts into gross revenues for the period and caused significant losses.

In addition, the airlines' record during March again focuses attention on the soft susceptibility of the industry to such factors as major accidents or a lack of confidence in business generally—an anomaly that has been apparent during the first quarter despite good earnings. The traffic decline was a complete reversal of the steady rise in the gross national product, whose trend generally sets the pace for airline revenue passenger miles (AW Feb. 29, p. 38).

Telling Effects

Although early signs indicate that the industry recovered from the March slump in April primarily as a result of heavy Easter holiday travel, the depressing showing during the month will have telling effects on some carriers. There is no doubt that Capital's current financial plight (AW Apr. 25, p. 43) was accelerated by a 15% traffic decline that forced the carrier to drop a refinancing program that would have forestalled a court petition for foreclosure by Vickers-Armstrongs, Ltd., on the company's flight equipment.

It is still too early to determine whether first quarter showings will force some revisions of optimistic forecasts made at the beginning of the year which estimated that gross revenues for the entire U. S. scheduled airline industry would reach a high of $2.9 billion (AW Dec. 28, p. 27). However, the effects of the March traffic declines are strongly reflected in first quarter results.

For example, American Airlines was able to reverse the industry trend during the month with a 2% increase in first-class traffic and a 26% increase in coach traffic.

Despite this relatively good showing, coupled with an estimated 22% increase in gross earnings during the first quarter, the airline showed a $453,000 net loss for the period. C. R. Smith, American president, emphasized that the deficit in the face of a revenue increase underscores the urgent need for an increase in airline fares.

Braniff will report a first-quarter loss despite an 11.8% increase in revenue passenger miles during March. The airline attributed its red-ink figure to loss of public confidence in the Lockheed Electra turboprop transport following two crashes now under investigation by the Civil Aeronautics Board (AW Apr. 25, p. 40). The airline will report a 7% increase in first-class available seat miles and a 137% boost in coach available seat miles as a result of the introduction of turbine equipment, which will force a seven point drop in the over-all load factor.

Trans World Airlines, which will report a first quarter operating profit of $7.4 million, saw a 1% decline in first-class traffic in March and a 6.8% gain in coach traffic. Carrier's load factor dropped from 63.8% to 57.1% during the month.

Northwest was the only one of the 12 trunklines to realize a load factor increase during March. Available seat miles during the month were held to a .9% increase, while revenue passenger miles climbed 2%. Non-recurring jet training expenses and a 29% jump on flight equipment depreciation costs were given as the main reasons behind the $631,733 net loss the airline will report for the first quarter.

During the first quarter, United was forced to cut capacity by an estimated 7% to permit training of flight crews on turbojet equipment. The airline experienced a net loss of $4.1 million during the first quarter, but a gain of $1.3 million on the sales of surplus piston-engine aircraft reduced the loss to $2.8 million.

United's Revenue

United's passenger revenues for the quarter were down 7.7%—a result of "unusually severe winter weather" and reductions in scheduled capacity, according to the airline's president, W. A. Patterson. In March, United's first-class traffic fell 16.5%, while coach traffic showed a marginal rise of slightly over 1%.

Western Air Lines reported substantial increases in all categories of travel during March. First-class revenue passenger miles rose 26%, coach traffic was up 7%. Western Air Lines will report a net profit of about $750,000 for the first quarter.

The impact of the travel depression on the trunklines was regional in character. Airlines suffering the heaviest setbacks were those whose major routes are confined to the area east of the Mississippi River. Exceptions were Delta Air Lines, with a 6% increase in first-class traffic and a 9% boost in coach revenue passenger miles. Northeast showed losses in coach traffic, but a substantial 10% climb in first-class traffic gave the carrier a 2% over-all traffic increase.

Delta Air Lines, which operates on a fiscal year ending June 30, reported a net profit after taxes of $1,103,189 for the nine months ending Mar. 31. Operating revenues for the period were $85.7 million—a 12% increase over the same period of last year. Operating expenses climbed 22% to reach $83.5 million.

Upturn in Northeast's traffic during the first quarter is expected to place the

Soviet Justice

Moscow—Soviet justice has triumphed in the case of "aerial profiteers" in the form of Aeroflot crew members who were caught red-handed in the act of transporting black-market fresh salmon from Baikal to Irkutsk in Siberia (AW Apr. 4, p. 51).

Komsomolskaya Pravda reports that the pilots concerned have been issued "severe reprimands." In addition, one An-2 captain was fined the cost of the illegal free transportation of the salmon.

Charges against the Russian pilots were: delaying a flight without justification while obtaining the salmon, using their official positions for private purposes and bringing discredit to Aeroflot's flying personnel.

Domestic Trunkline Traffic

March 1960

Carrier	Revenue Passenger Miles (000 omitted) 1960	1959	Per Cent Change	Available Seat Miles (000 omitted) 1960	1959	Per Cent Change	Load Factor (per cent) 1960	1959
American	462,258	419,334	10.2	762,351	630,315	20.9	60.6	66.5
Braniff	84,392	75,504	11.8	165,000	128,646	28.3	51.1	58.7
Capital	121,591	144,065	−15.6	246,388	245,152	.5	49.4	58.8
Continental	62,575	33,588	86.3	129,625	66,626	94.6	48.2	50.4
Delta	153,276	139,147	10.2	262,909	237,388	10.8	58.3	58.6
Eastern	374,382	430,382	−13	714,292	758,315	− 5.8	52.4	56.7
National	101,460	125,729	−19.3	179,429	195,653	− 8.3	56.5	64.3
Northeast	48,557	52,869	− 8.2	96,026	93,902	2.3	50.5	56.3
Northwest	111,629	109,444	2	213,167	211,232	9	52.3	51.8
TWA	318,483	309,678	2.8	557,702	484,684	15.1	57.1	63.8
United	355,271	390,078	− 8.9	610,265	637,811	− 4.3	58.2	61.1
Western	77,731	65,542	18.6	137,491	108,226	27	56.5	60.6
Total	2,271,598	2,295,360	− 1	4,074,645	3,797,950	7.3	55.7	60.4

airline in the black after showing heavy losses in 1959 which are now estimated at about $6 million. Eastern and National airlines were hard hit by the March traffic depression, with Eastern feeling the pinch of a 17% decline during the month in coach travel, while National's first-class traffic plummeted 26% in the same period.

Capital has struggled during the first quarter against a steady decline in its traffic that brought about a three-month net loss of $5.4 million and an operating loss of $4.8 million. Passenger load factor for the system toppled 10 points from the 59.9% recorded in the first quarter of 1959 to 49.6.

Operating revenues dropped a sharp 11% from $26.6 million for the first quarter last year to $23.6 million during this year's first three months. Operating expenses in the same periods jumped from $26.9 million to $28.4 million.

Revenue plane miles flown were down and passenger miles sold took a substantial dip.

Industry observers are not inclined to feel that the Capital crisis is necessarily the beginning of a general debacle among regional trunklines, although they admit that the case is an indication of the future awaiting carriers which are not fortified with sufficient resources to carry them through critical periods.

If general business conditions remain firm and normal traffic trends are restored for an extended period of time, the industry should prosper sufficiently to permit a 14% increase in revenue passenger miles in 1960 over 1959 as originally forecast by AVIATION WEEK (AW Dec. 28, p. 29).

There are considerable signs of a weakening of the general economy such as falling stock market prices and a continuing lower drift in the production of steel.

However, consumer income is at record heights—the gross national product for the first quarter is estimated at close to the $500 billion mark, and capital spending appears headed for a substantial increase this year. Thus, if the economy remains strong, most carriers can expect to experience an upward traffic trend.

Principal problem lies in maintaining a breakeven load factor that will permit a profitable operation—a problem that grows more severe as additional turbine aircraft multiply the industry's seat productivity. Whether this over-capacity will force some carriers to the wall remains to be seen since it is not yet possible to determine which competitive weapons will be used to keep load factors at a healthy level.

Attracting Passengers

For example, introduction of reduced rates as a means of attracting passengers would give the initiating carrier only a temporary advantage since most major carriers would promptly match the rates, creating substantial cuts in gross revenues and a general deterioration in rate structures. The industry is virtually unanimous in its opinion that, in many major markets, a general fare reduction does not necessarily sufficiently generate enough new traffic to offset the loss in revenues resulting from the cut.

Another unknown factor in assessing the effects of an over-capacity problem is the influence such a situation will have on aircraft utilization (see p. 43). At present, major carriers are converting piston-engine aircraft into all-cargo carriers as one means of keeping the fleet operating at efficient utilization earning rates.

Continental has managed to maintain one of the highest jet utilization rates in the industry and in March experienced a 95% increase in available seat miles as a result. Coach available seat miles alone climbed 465% during the month as new schedules were introduced and a high utilization rate was maintained.

Net effect was to pull the carrier's system load factor down from 50.4% to 48%. Nevertheless, the airline showed an operating profit of $811,000 during the first quarter and net earnings of $54,000 for the period. Total operating revenues climbed 73% to $13.5 million while operating expenses were held to a 66% rise.

Industry's experience with turbojet schedules last year lend strong support to the theory that the equipment will develop new traffic and open new markets. In 1959, most jet operators reported load factors in the high 80s and low 90s without any disturbing evidence that traffic was being drained from piston-engine services. United, for example, which operated with piston-engine transports against jet competition on its major routes through most of 1959, showed a climb in revenue passengers carried from 7.2 million in 1958 to 7.5 million last year.

Approximately 40 new turbojet transports will be introduced into scheduled service during the second quarter of 1960. As a result, load factors by late summer should indicate whether the industry is faced with an over-capacity problem, and if so, which carriers will survive the impact of decreasing revenues, towering expenses and heavy costs of low utilization. If the economy fails to hold its present strength or if the accident record is not arrested, this ultimate test may arrive before the end of the second quarter.

Fight Narrows in Air Alert Controversy

By Katherine Johnsen

Washington—Heated controversy over the need for an airborne alert for Strategic Air Command's Boeing B-52 bombers to avert a possible knockout blow from Soviet ballistic missiles during the critical 1961-63 "missile gap" period has largely narrowed to a question of whether an "on the shelf" alert capability should be built for one-eighth or one-fourth of the B-52 fleet.

In closing testimony on the Fiscal 1961 budget before the House Appropriations Armed Services Subcommittee, SAC Commander Gen. Thomas S. Power agreed with a Mar. 4 written statement to him by the Joint Chiefs of Staff that an airborne alert is not necessary "right at this moment" (AW Apr. 11, p. 34). Gen. Power said the proposition is "academic" since there is no present capability to sustain it. The recent JCS memorandum to Power was in reply to a communication on airborne alert need he presented to the chairman of the Joint Chiefs on Mar. 6, 1959.

"If I put the force on airborne alert . . . a per cent of it on alert right now, I would destroy the force more thoroughly than Mr. Khrushchev could destroy it, because it would run out of parts and would be grounded," Gen. Power said.

Gen. Power told the subcommittee that the issue at stake is between a program for an on-the-shelf capability for one-eighth of the SAC B-52 fleet supported by the Joint Chiefs and the Administration, or a program of on-the-shelf capability for one-fourth of the fleet as advocated by Gen. Power and supported by USAF Chief of Staff Gen. Thomas D. White. A total of 704 B-52s are programed for SAC's 14 heavy bomber wings.

"I think we should have an on-the-shelf capability for the highest possible, or practical, percentage of the heavy force," Gen. Power told the subcommittee. "I think it is possible to maintain one-quarter of the force."

Gen. Power said his proposal for expansion of SAC's on-the-shelf air alert capability would require $571 million in Fiscal 1961 in addition to the $185 million in the Fiscal 1960 and 1961 budget requests for the JCS plan.

Gen. White presented Gen. Power's air alert program to the Joint Chiefs in connection with the Fiscal 1961 budget, and it was rejected.

Other Highlights

Following are other highlights of Gen. Power's testimony:

• **Convair B-58** supersonic bomber. Gen. Power said he "would like to reserve judgment" on this program until next year but strongly supported the $500 million in Fiscal 1961 budget requests for procurement of 30 B-58s. He said the B-58 is "a bird in the hand" for protection in the critical period before 1965 and resisted suggestions by subcommittee members that B-58 funds be shifted to accelerate the more advanced North American B-70 Mach 3 bomber program, which is not expected to be operational before 1966 or 1967 under present planning. Considering contract termination costs, if the B-58 program were canceled, Gen. Power said, "you would probably end up, at this stage of the game, where you wouldn't save any money . . . you would be taking money from something that is supposed to protect you . . . in 1961 and 1962 to do a job for you in 1965. From a timing point of view I don't think that is particularly sound." He also told the subcommittee that he is "satisfied" with the Fiscal 1961 B-58 program. In earlier congressional testimony, however, he supported an acceleration of the program (AW Feb. 8, p. 35).

• **Polaris fleet ballistic** missile system. Gen. Power viewed Polaris as "a very promising weapon system," but challenged Navy contentions that submarines would carry war away from the U.S. continent. First, he said, Soviet ballistic missiles would not be directed against submarines and "you have freed them to attack cities in the U.S." Second, he said, enemy ballistic missiles would be directed against Polaris missile and nuclear submarine facilities in the U.S. Gen. Power also told the subcommittee that as to cost Polaris compares unfavorably with USAF's Minuteman solid-propellant ICBM. "You could buy eight hardened and dispersed Minutemen for one Polaris," he said.

• **Missile defense.** When Soviet ballistic missiles become available in numbers in the mid-1960s, Gen. Power said, "civil defense will become a large part of our deterrent posture . . . civil defense and what you are doing is a visible sign of your determination to survive. It is tremendously important."

• **North American B-70.** Terming the B-70 "a dramatic step forward" in manned bombers. Gen. Power urged an increase in the Administration's $75 million Fiscal 1961 research program for the B-70 to provide for development of such subsystems as the bomb bay unit, electronic countermeasures systems and communication systems. USAF had wanted $464 million for the B-70 in Fiscal 1961. "You have growth in the B-70 because you are on the low part of the curve as far as the ability to withstand heat is concerned," Gen. Power said. "You program metals and materials in it that have the qualities to withstand extreme heat." Should a defense against missiles be developed, he warned, the decision on the B-70 would become "tremendously important." Gen. Power estimated that by the mid-1960s SAC's ratio of missiles and manned bombers would be approximately 50-50, in 1964 SAC would begin "dramatically" phasing down the manned bomber but that bombers would never be "completely" phased out. "I think you are going to always have to have a man over enemy territory," he said.

Dyna-Soar Configuration Resolved

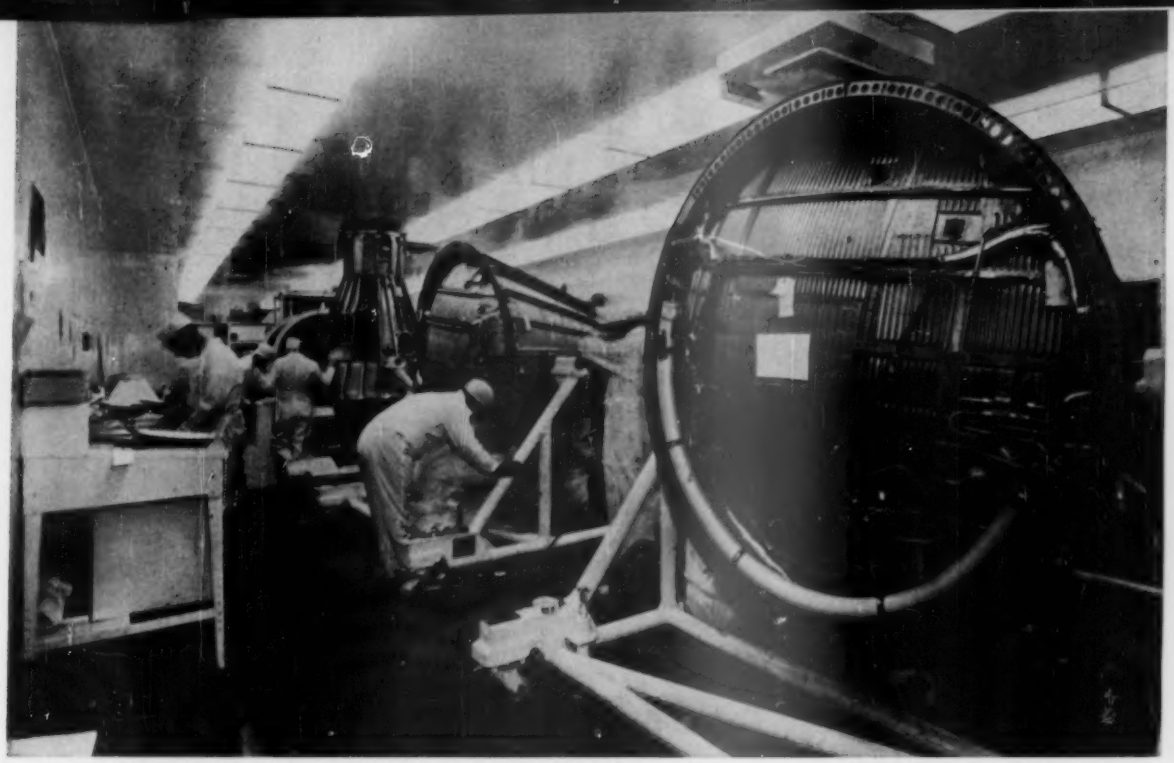
Washington—Controversy over the shape to be used for the Dyna-Soar vehicle was settled last week with the announcement that Boeing Airplane Co. will stick to the original concept of a winged glider. Design and ground testing will begin immediately.

Subcontractors will be selected in competitions over the next four to six months. Whether they will be subcontractors to Boeing or associates directly under the Air Force has not been decided. A mockup of the glider is due to be ready about a year from now.

Strengthened Martin Titan-J booster will be used through the unmanned and manned orbital flights. Some of the modification work will be done at the Baltimore plant. Boeing will build 11 gliders—three for ground tests, four for unmanned boost flights and four for manned boost flights. Titan will carry the program, which should end late in 1964, through the suborbital phase. An improved Titan or possibly an improved Atlas will be used for orbital tests, and, if the vehicle grows into an operational weapon system, Saturn will be used.

One and possibly two existing Titan pads at Cape Canaveral will be modified for Dyna-Soar launchings.

USAF has released $29.7 million in Fiscal 1959 and 1960 funds and has $58 million in Fiscal 1961 budget requests for the program. Total program is expected to cost about $800 million over the next five or six years **(see p. 23).**



McDonnell Builds Mercury Subsystems in Superclean Rooms

Mercury manned capsule subsystems are integrated into capsule itself in one of two McDonnell Aircraft Corp. superclean rooms, where filtration system removes dust particles down to 3/10 micron in size from the air. Rooms are maintained at 75F dry bulb temperature and maximum of 50% relative humidity. Uniform lighting provides minimum of 160 ft. candles as compared with 70 ft. candle standard for assembly in many aircraft plants. Precautions are aimed at reliability. Emergency escape system test using the first McDonnell capsule delivered to National Aeronautics and Space Administration is due soon at NASA's Wallops Station, Wallops Island, Va.

Eight Countries Join In Hanover Air Show

Hanover—International participation on a large scale in this third postwar Hanover Air Show underlines the growing importance of West Germany as a major producer and customer for aeronautical material.

Eight countries sent aircraft and products to the show, demonstrating Italian sport planes, British lightweight and heavyweight freighters and America's Mach 2 Lockheed F-104 Starfighter. Many static displays showed joint efforts put on by foreign firms in association with German licensees or subcontractors, such as United Aircraft's participation with Weser Flugzeugbau or General Electric's with BMW.

Observers at the show are convinced the German show will provide an off-year balance to the long-established French Salon Internationale d'Aeronautique. Present plans are to hold the next German show in 1962, avoiding conflict with the next Paris show scheduled for 1961.

Size and content show visible proof of a startling postwar comeback in German aircraft industry. Although two years ago the industry employed about 10,000 workers and was programed to remain that size, employment now is up to more than 20,000 and steadily rising.

Curtain-raiser to the flying display was the appearance of a USAF F-104C flown in from a Spanish base. Supersonic Lockheed fighter and Fiat G.91, both chosen to equip the new Luftwaffe, are centers of interest in the outdoor aircraft display. Perennial Hawker Hunter two-seater trainer was a runner-up for interest. West German Defense Minister Franz Josef Strauss took a 30 min. flight in the trainer.

West Germany's first jet transport design, Hamburger Flugzeugbau's HFB-314, was shown in model form.

Nuclear Nozzle Award

Washington—Rocketdyne Division of North American Aviation, Inc., has won a National Aeronautics and Space Administration competition to develop and deliver six hydrogen-cooled rocket nozzles for tests with a breadboard nuclear rocket engine (AW Apr. 18, p. 26). Seven companies entered bids. Nozzle will be used next year with a Kiwi reactor as part of the NASA-Atomic Energy Commission Rover nuclear rocket development program.

Aeronutronic Wins Lunar Capsule Award

Washington—Aeronutronic Division of Ford Motor Co. was chosen by National Aeronautics and Space Administration last week to build a 300 lb. instrument capsule which is to make a rough landing on the moon within the next two years, as revealed by AVIATION WEEK (Apr. 25, p. 26).

Instrument capsule will be ejected from a lunar probe being built under Project Ranger by NASA's Jet Propulsion Laboratory. JPL will provide technical direction for the Aeronutronic project and will negotiate the contract.

Aeronutronic estimates that the capsule program will cost about $3.5 million. After 13 companies submitted bids in the competition, NASA asked Aeronutronic, Hughes Aircraft and North American Aviation's Missile Division to prepare advanced capsule design studies. Aeronutronic's proposal was chosen for contract negotiation.

Atlas Agena-B will be used to launch the 800 lb. lunar vehicle on its 60-70 hr. flight. Lunar probe will carry a television system for photographing the surface of the moon, as well as other scientific instrumentation and the 300 lb. capsule.

Tiros Exceeds Weather Bureau Hopes

By Evert Clark

Washington—Information returned by the Tiros experimental weather satellite has exceeded expectations and has made meteorologists "quite decidedly optimistic" about the value of a complete system of satellites, according to Weather Bureau officials.

The satellite, launched on Apr. 1 by National Aeronautics and Space Administration, has made discoveries, provided information from vast areas of the globe that have been almost unobserved before from the meteorologist's point of view, and is returning television images of good enough quality that they are "a very unexpected, happy surprise to all of us," according to Dr. Harry Wexler, director of meteorological research for the bureau.

Dr. F. W. Reichelderfer, chief of the bureau, said that although systematic inspection of the pictures returned so far is just getting under way, "initial results from this one experimental satellite lead us to believe that a new era in meteorological observing is about to open for us."

Despite several operational difficulties with the satellite itself, Tiros already has provided information on "these enormous blank areas (mostly over oceans) where storms can reside undetected for a week or so without our knowing about them," Wexler said. He said that "perhaps only one fifth of the atmospheric mass is anywhere reasonably observed nowadays," and the cost of supplying ground and sea stations to obtain adequate coverage is prohibitive.

Wexler said that to predict the weather for Washington, D. C., for "the next day or two . . . it is all right to have observations perhaps for one or two thousand miles around Washington . . . but if you are going into predictions for Washington beyond that time, you have to know observations far out in the Pacific, over the Arctic, Siberia and so on. And if you go beyond that, if you are trying to get some idea of what outlooks might be 30 days hence, one should have observations for even a larger area, perhaps the whole earth."

Cost of a satellite system cannot be compared directly with that of a ground and sea-based system because the satellites are supplementary. They do not, for example, provide information on pressure, temperature, humidity, wind velocity and direction, etc., as a series of radiosonde balloons would, Reichelderfer said. They could, however, supplement hurricane reconnaissance aircraft.

"If we were to do the whole job by aircraft as we thought at one time we might have to do," Reichelderfer said, it would take a lot of airplanes to cover the whole expanse of oceans. Eventually, if the satellite can point out where the storms are, then relatively few aircraft can cover it, going out and seeing what it is made of.

"I think it is safe to say if you try to do the whole job by means other than satellites, the cost would be greater," Reichelderfer said. Cost of maintaining "a very few" weather ships stationed in the Atlantic runs $25 million to $50 million a year, he said.

In addition to covering blank areas, future satellites equipped with infrared equipment, radars, etc., will "give us a basic understanding of the energy input and output of the atmosphere complex," Wexler said.

Other Achievements

Meanwhile, Tiros already has:

- **Revealed** that the atmosphere "seems to be capable of an immense variety of scale" in producing cyclonic areas.
- **Revealed** "an unexpectedly large degree of organization in cloud systems."

Tiros observed a storm with a 1,000-mi. diameter vortex some 800 mi. west of southern California on Apr. 4. Wexler said this was "a rather unusual place for a storm, where usually anticyclones are found," and said the Weather Bureau "had a few ship reports" from the area between California and Hawaii which led it to believe there was a storm there, but "we had no details."

"We certainly would not suspect, from the few observations we did have, this amount of structure to the storm. The interpretation of this amount of structure we are not in a position to make. This is new to us really. This will form a subject for study in the months and years to come," Wexler said.

The storm consisted of a "very large banded structure—clear, cloud complex, clear again, another cloud complex," Wexler said. "But then the individual band is broken up into a series of smaller bands, and probably if we had fine enough detail there would be smaller bands within those."

This degree of organization in large cloud systems is perhaps Tiros' most important discovery so far. Reichelderfer said:

"It is well known from radar observations that hurricanes are characterized by bands of clouds which spiral inward around the storm center. Now, as a direct result of Tiros, we have seen that spiral banded cloud structure also exists around well-developed storms located outside of the tropics."

Wexler said meteorologists knew that storms rotated about a center, but that "in the case of hurricanes, during the war when radar was first used to observe hurricanes, to everyone's astonishment instead of a solid cloud mass rotating around a center, it was found that the cloud was broken up into bands, circular bands, spiraling in toward the center, bands perhaps being 20 to 30 mi. wide with clear spaces of perhaps the same dimensions between.

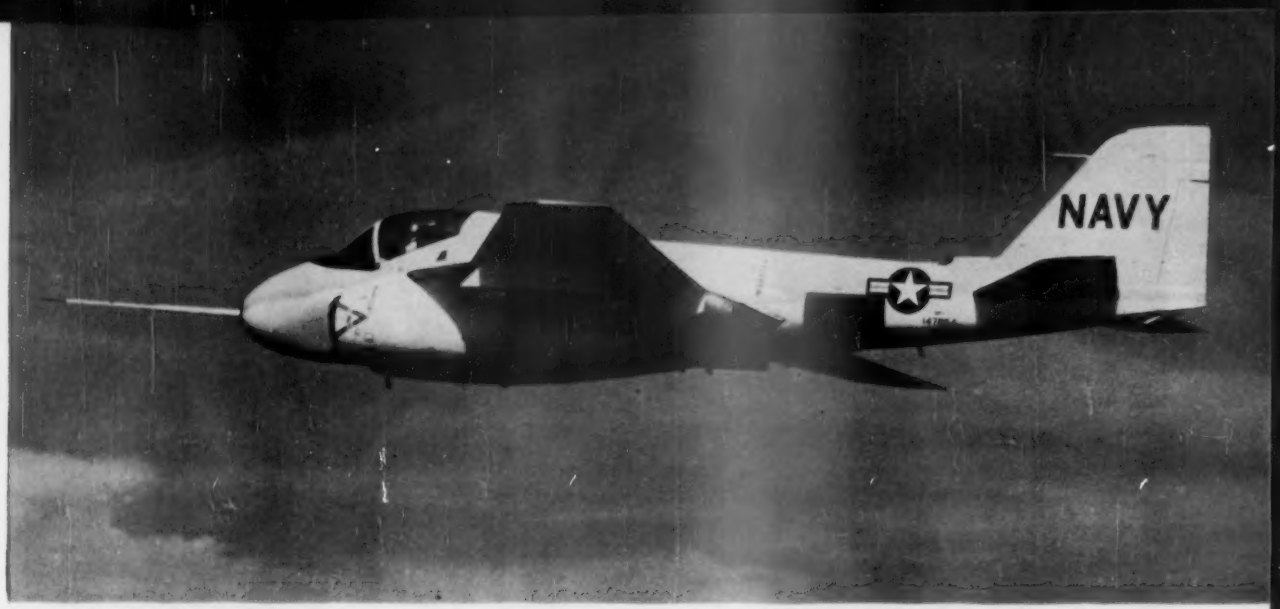
"But no one really suspected that outside of the tropics these storms would have such structure," Wexler said. "Maybe some hardy souls made a prediction or surmised it but nobody really showed any definite proof. I would say this is the first definite proof we have that a large percentage of such storms as tropical storms do have such a banded structure.

"We are curious to see how high a percentage will finally emerge when we examine a lot more cases, and whether there is a true difference, say, between storms of the continental areas and storms over the oceans, whether there is more banded structure for oceanic storms than there is for continental storms."

Tiros observed a 1,500-mi. diameter storm 300 mi. west of Ireland on Apr. 2 and again the next day. On the first day, circular bands of clouds ranging in widths from 20 to a few hundred miles spiraled around the center. By Apr. 3, the circulation pattern had changed and instead of a few smaller bands there was one very large band, perhaps 150 mi. in width, winding around the center.

The satellite also was programed to look at a typhoon off Australia on Apr. 10. At that time, the Australian Meteorological Service had only three reports from the storm area. Wexler said Tiros photos showed "quite a lot of detail that you would not suspect from the surface observations."

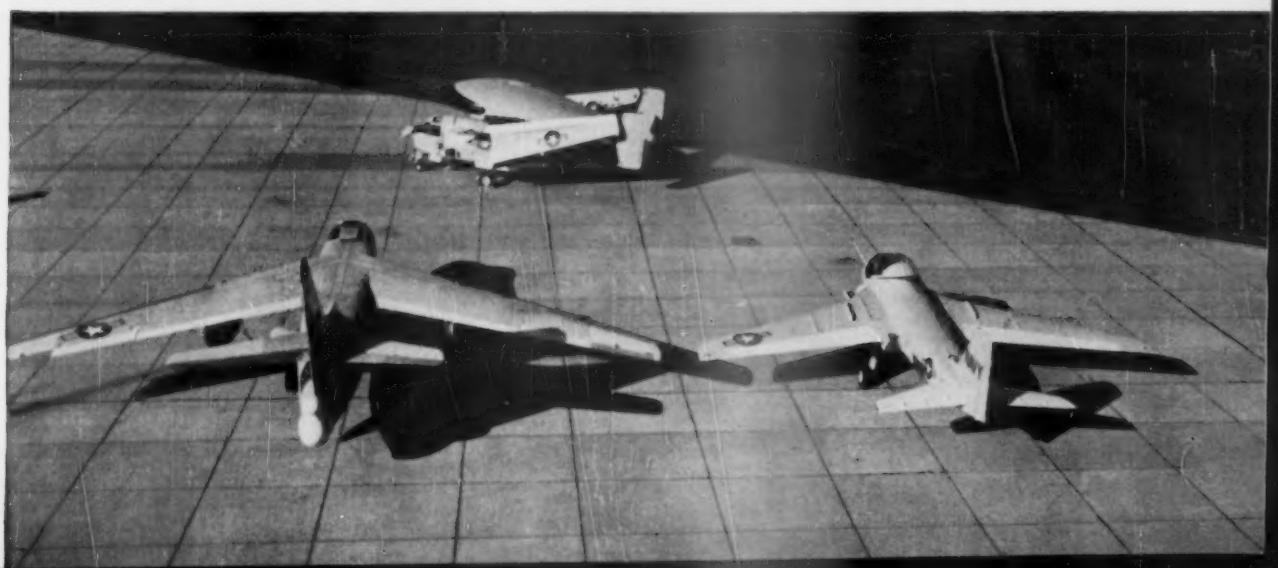
After the 22nd orbit, Tiros' high-resolution camera no longer could record images for relay to earth. William G. Stroud, chief of meteorology for NASA's Goddard Space Flight Center, said there also is continuing trouble with the horizontal scanner which was to indicate satellite attitude, "but neither of these is catastrophic in any sense."

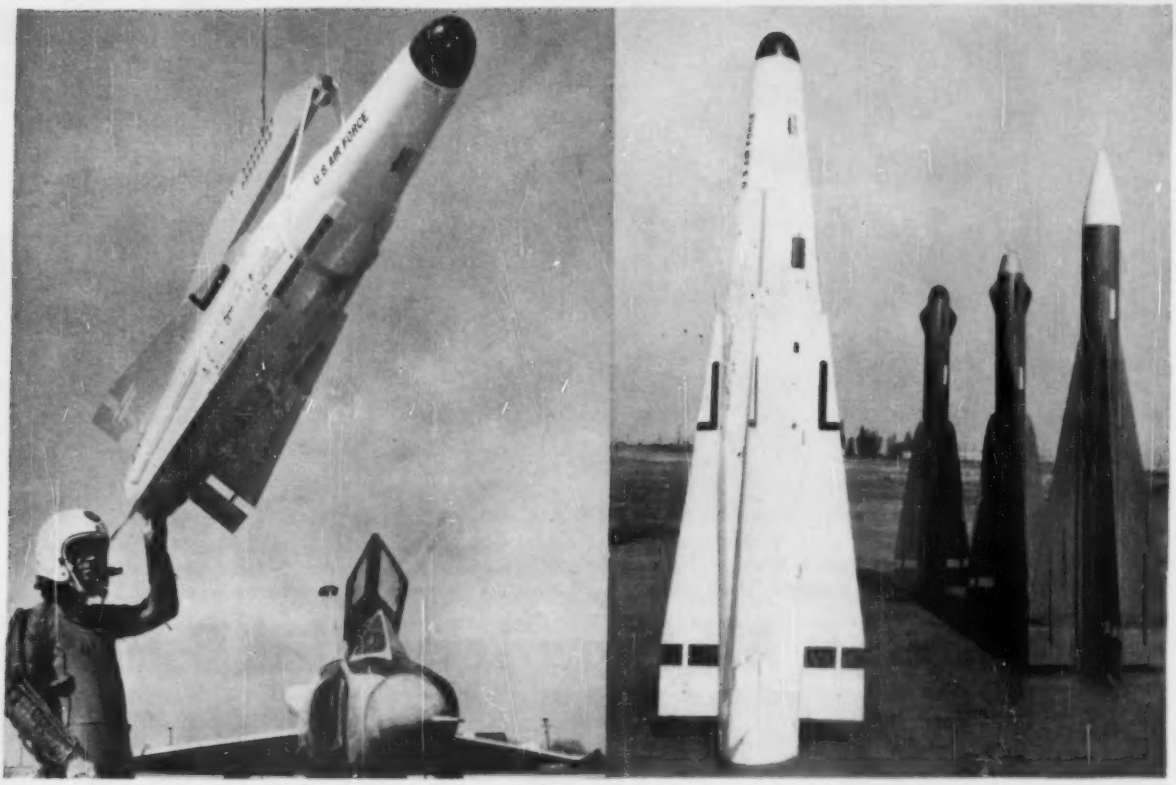


Grumman's A2F-1 Intruder low level attack bomber, formally rolled out last week following its first flight, is designed to maintain Mach .9 at sea level. Powerplants are two Pratt & Whitney J52P-6 turbojets delivering 8,500 lb. thrust each. Variable tailpipes can be lowered for STOL effect during takeoffs and landings. Stores probably will include the Temco Corvus air-to-surface missile.

Grumman Flies A2F-1 Low Level Attack Bomber

Completely obscured targets will be visually represented to A2F's pilot through an electronic integrated display system. This system also provides data for the aircraft's digital integrated attack navigation system (DIANE) by which the pilot can preselect an automatic course of action for the aircraft including approach to target, weapon discharge and escape. Below, the Intruder is shown in comparison with the Grumman WF-2 antisubmarine warfare plane and the Douglas A3D attack bomber.





Hughes GAR-11 Falcon With Nuclear Warhead Unveiled

Nuclear warhead Hughes Falcon, GAR-11, new air-to-air missile to be carried by Convair F-102, will permit effective head-on attacks against supersonic bombers. New Air Force missile, developed by Hughes Aircraft Co., will supersede the MB-1 Genie unguided nuclear rocket now used on Northrop F-89s. First models of the GAR-11, being produced at Hughes' Tucson, Ariz. plant, were delivered in March for test and evaluation. Nuclear Falcon will go into operational use later this year. Latest member of the Falcon family measures 7 ft. long, 11 in. in diameter, weighs slightly over 200 lb. (right). The GAR-11 is about 6 in. longer than earlier GAR-1D (second from left) radar-guided Falcon, GAR-2A infrared guided Falcon and GAR-3 Super-Falcon (extreme right). GAR-11 is about twice the diameter of other Falcons, to accommodate nuclear warhead. New missile, like the GAR-1D and GAR-3, employs inactive radar guidance, homing on radar energy that is bounced off target by intercep tor's radar. Control surface configuration resembles GAR-3. The GAR-11 can be carried in mixed loads with other types of Falcons.

USAF Reorients Pilot Training; Will Abandon Contract Schools

Washington—Air Force plans to consolidate pilot training operations next year in a new flight training program that will eliminate the use of civilian contract primary schools.

Under the new program, students will receive all their flight training at one base, and all the training will be done by Air Force pilots. The combined program will be operated at six bases.

USAF says this new approach will save money by eliminating student moves between bases and reduce student eliminations from the program as a result of continuous supervision at a single base. New program will mean training can be done with fewer bases, and USAF said the use of Air Force pilots for instructors will give "valuable jet flying experience to more Air Force flyers."

Contractors object to the new program on the grounds that it is not an efficient or economical way of training pilots. Civilian contractors trained over 200,000 pilots during World War II and have trained more than 40,000 since primary contract training was resumed in 1951.

Training volume has been declining in recent years with reduced Air Force need for pilots.

Navy conducts all its own flight training. Army curently has contractors operating a fixed-wing training school at Ft. Rucker, Ala., and a helicopter school at Camp Wolters, Mineral Wells, Tex.

Air Force plans to conduct consolidated training programs at Webb AFB, Big Spring, Tex.; Reese AFB, Lubbock, Tex.; Vance AFB, Enid, Okla.; Craig AFB, Selma, Ala.; Moody AFB, Valdosta, Ga., and Williams AFB, Chandler, Ariz. Williams AFB currently is a Tactical Air Command base; this function will be absorbed by Luke AFB, Phoenix, Ariz., in November, and training will start at Williams in January.

Moody AFB is now an intercepter pilot school. This training will be terminated in November, and Moody will launch the new program in April, 1961. Basic instructor course at Craig AFB will be transferred to Randolph AFB, San Antonio, Tex., this summer. Laredo AFB, Laredo, Tex., will continue its basic pilot training program until early next year. Later use of the Laredo facility is now under study.

Basic flying school at Greenville AFB, Greenville, Miss., will be converted to a technical training school for firefighting and administrative training. These schools are now located at Lowry AFB, Denver, Colo., and Lackland AFB, San Antonio.

Contractors and bases to be eliminated under the new program include:

- **Beiser Aviation Corp.,** Moore Air Base, Mission, Tex.
- **Southern Airways School,** Bainbridge Air Base, Bainbridge, Ga.
- **Pittsburgh Institute of Aeronautics,** Graham Air Base, Marianna, Fla.
- **Hawthorne School of Aeronautics,** Spence Air Base, Moultrie, Ga.
- **ServAir, Inc.,** Bartow Air Base, Bartow, Fla.

Flying training is to be completed at these bases by the end of 1960, and they are scheduled to be closed by the end of March, 1961.

United Aircraft Will Resist Union Demands in Face of Strike Threat

New York—United Aircraft Corp. would rather take a strike than accede to current union demands for a union shop or full compulsory arbitration, H. M. Horner, UAC chairman, told the New York Society of Security Analysts last week.

Contracts at various plants and divisions of the corporation expire over a period of December through May (AW Mar. 21, p. 26). By continuing to work without contract at plants where expirations have taken place, the unions will be in a position to call virtually a corporation-wide strike by mid-month, Horner said.

Wages do not seem to be a primary issue, Horner said. As for the union shop, he added, United is opposed to it "for obvious reasons."

United is not opposed to arbitration on specific points of a union contract, which are a matter of law. But the company is strongly opposed to compulsory arbitration of any broad issue.

In practice, when such issues are taken before a judge, Horner said, there is a tendency on the part of the judge to throw up his hands, cry, "A plague on both your houses," and give each party half of what he wants. "This way the union always gets half of what it wants," he said, "and this is the way you give away the shop."

Other Points

Other points Horner touched on:

- **Sikorsky's S-60** flying crane helicopter looks like the most promising company-sponsored project in terms of potential dollar value within the next three-four years. The S-60 is a big, expensive helicopter, he said, but it appears to have a wide, international market and could draw orders for as many as 200. Horner made it clear the time span involved here was important and that there are other projects which might produce more revenue farther in the future.
- **Continuous trickle** of reorders rather than another big round of airline purchases is the likely future pattern for jet transports. There will have to be orders for a small jet transport, but what airplane it will be—Sud Caravelle, Boeing 727 or Vickers VC.11—is not clear yet.
- **United could show** an immediate return to higher earnings if it dropped its company-sponsored research and development programs. It has spent $155 million for facilities in the three years ending in 1959 and will spend $40 million this year and perhaps that much next year.

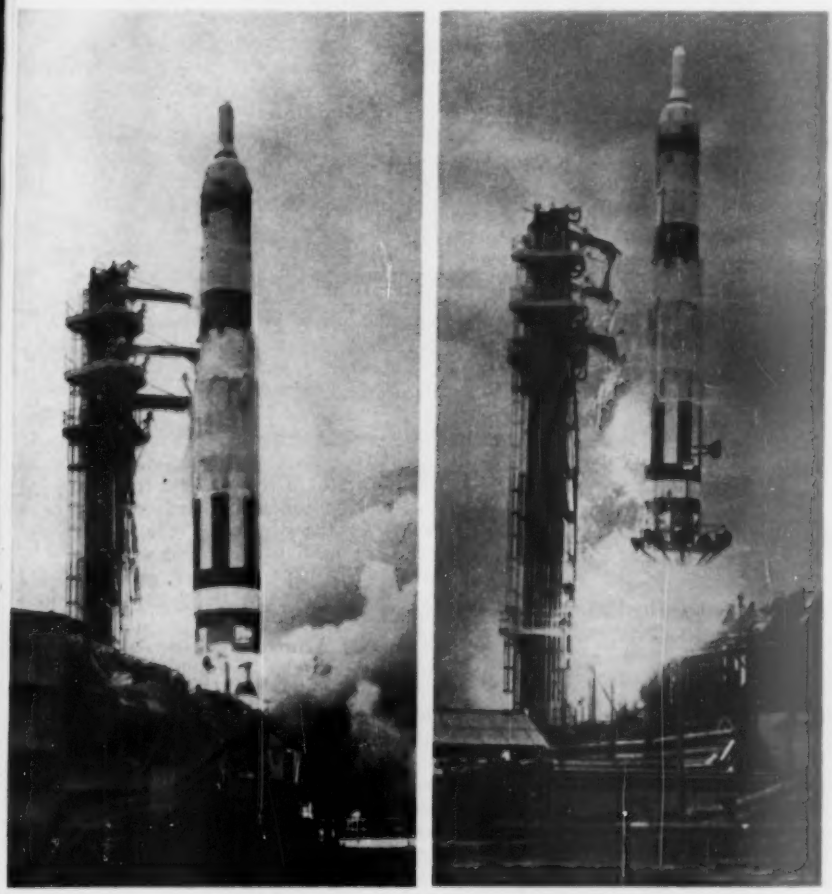
Sponsored Engineering

Horner said company-sponsored R&D is essential for growth. United could rely on sponsored engineering—it has $200 million in such contracts now—but the company would not develop in this fashion.

Dealing specifically with United's West Coast research subsidiary, Horner pointed out that the company is spending substantial sums of its own for test firing of small solid propellant rockets using several new propellants it is investigating. This operation will require new mixing facilities, test firing stands and a new engineering building.

But sponsoring this work itself protects United in the proprietary rights for such developments. "We hope to get basic patents in this field," he said, "before we take any contracts in it."

Horner said United first quarter sales will be approximately $270 million, $20 million above the first quarter of 1959. Earnings will be somewhat lower than last year's $1.20 a share—probably pennies under a dollar, he said. Commercial sales were estimated at $83 million compared with $39 million for the period a year ago.



USAF-Martin Titan G-5 Firing

Air Force-Martin Titan G-5 was recently fired 5,000 mi. in the third full-range test of the ICBM. Data capsule was recovered from the prototype Avco Mark IV re-entry vehicle. Test was the 13th since the Titan flight test program began in February, 1959, and the third full-range test since Feb. 24, 1960. Martin reports nine test flights were completely successful and that two were partial successes. Remaining two Titans exploded at launch.

Defense, State Department Policies Rapped

By Ford Eastman

Washington—State Department policies and Defense Department organization have failed to keep pace with the scientific revolution that has produced major changes in weapon systems and military strategy, Dr. James A. Perkins, vice president of the Carnegie Corporation, charged in testimony last week before the Senate Subcommittee on National Policy Machinery.

"The global sweep of modern weapons makes it clear that foreign policy and military policy are inextricably linked," Dr. Perkins said. "And yet there are few indications, indeed, that this fact has influenced either the organization or the procedures of the Department of State."

There is no high official in the Department who has these considerations as his specific responsibility, Dr. Perkins said. He added that, so far as he knows, there are no regular briefings of top State Department officials on the military aspect of U.S. foreign policy.

"Just as modern weapons require military knowledge in the State Department," Dr. Perkins said, "modern weapons and derived modern strategy have made largely obsolete existing organization in the Pentagon. If anything is clear, it is that modern warfare does not divide itself up into problems of land, sea and air. Weapons have made the globe one large integrated battlefield, and strategy, tactics and the organization to support these must recognize this fact."

Dr. Perkins told Sen. Henry M. Jackson (D.-Wash.), subcommittee chairman, that functional tasks are now divided along the lines of strategic deterrence, limited warfare, continental military defense, civil defense and military assistance to allies. He added, however, that it has been impossible to assign tasks on a functional basis along existing service lines and that "tradition, requirements of service morale and plain inertia have kept us from making the necessary hard decisions to really unify the separate services and to create an organization in accordance with the tasks to be performed."

The hearings were scheduled to determine "how our government can best gear science and technology into foreign and defense policy-making."

In addition to reorganization of the Defense Department on a functional basis, Dr. Perkins recommended that the State Department consider:

• **"Appointment of a civilian** officer" for military affairs at the level of assistant secretary.

• **Assignment of at least** two dozen middle-grade officers a year to the National War College for its regular program of courses and instruction.

• **Development of appropriate** relations with a semi-private research organization for assistance in the analysis of the military and strategic considerations involved in various foreign policies.

Dr. William H. Pickering, director, National Aeronautics and Space Administration's Jet Propulsion Laboratory, told the subcommittee that it is essential for the U.S. to do a better job in defining its national goals and in understanding the role science plays in both the military and non-military postures.

We must be concerned with defining our goals and making them known," he said, "as well as being concerned with funding, manpower and organizational matters—or in other words we must define the ends before trying to develop the means of getting there."

Asked whether the present situation requires government support or projects not specifically related to military weapon objectives, Dr. Pickering said "unequivocally yes."

The civilian space program is an obvious example, he said. Others which could have an equally important impact on world opinion, he said, include methods of weather control, development of fusion power and low-cost, practical power generation sources that might derive their energy from the sun or thermoelectric devices.

There are important scientific areas of national importance, Dr. Pickering pointed out, where private industry or universities are either not in the position to fund or lack the incentive to do so because of long-term investments.

He also told the subcommittee that:

• **"It is possible** for the government to do a better job of identifying and prosecuting crucial technological developments. This can be done only through the government inviting in and heeding the advice of the top scientists of the country." He said "the answer can only lie in establishing a definite and uncomplicated hierarchy of decision-making authority with competent, far-seeing men at each level who have the integrity and objectivity to make decisions and stamina to back them up.

• **"It is illusory thinking** to expect that very many of the serious problems facing government today can be solved by the appointment of ad hoc committees of well-intentioned citizens from private life. The important problems are generally so complex that, unless an individual is in a position to devote full time to familiarizing himself with all the factors to be considered and the implications of the various decisions that can be made, the chances are that judgment by opinion can only result.

• **"There is no question** but that we as a nation have failed in times past to realize the world prestige implications of major scientific developments. The situation in my opinion is improving, but I have doubts whether the average layman is yet aware of the import which the world, and in particular the underdeveloped nations, will attach to scientific breakthroughs in the future."

Dr. Herbert York, Defense Department director of research and engineering, told the subcommittee:

• **One of the drawbacks** to a budget cycle of three-to-five years instead of one would be that review of programs, which is required constantly, might be "put off" for longer periods.

• **Conflict of interest statutes** create one of the most serious problems in recruiting top technical people from industry for government positions, since most of Defense Department's research and development work is contracted to industry where the most competent people are working. In order for such persons to work in government, the law requires that all interests in the company be severed.

• **Science should be represented** at the cabinet level to provide support for and improve the state of science in the U.S. He added, however, that all science, particularly applied science, should not be brought into a single department but left to the various agencies concerned.

Saturn Award

Washington—Douglas Aircraft Corp. last week won the sharply contested National Aeronautics and Space Administration competition to develop and produce airframes for the S-4 upper stage for Saturn space vehicles. Initial contract will call for nine stages and cost more than $65 million.

Douglas will use its Thor missile team and build the stages at the Santa Monica, Calif., plant. Pratt & Whitney will supply the four 20,000-lb. thrust XLR-115 engines. At first, stages will be shipped to a static test site near Sacramento by barge, then go by ship and barge through the Panama Canal to NASA's Marshall Space Flight Center at Huntsville, Ala., for mating with the Saturn booster. Later, stages will go by water direct to the launch site at Cape Canaveral, Fla.

Contract includes seven flight test stages and two spares. Dummy S-4 stages for early tests of the booster may be supplied by Marshall. Eleven companies submitted bids for the S-4 contract (AW Mar. 7, p. 329).

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Ling-Altec, Temco Propose to Merge

Dallas, Tex.—Proposed merger of Ling-Altec Electronics, Inc., and Temco Aircraft Corp., both of Dallas, into Ling-Temco Electronics, Inc., is designed to establish a position now as a top company in the crowded, highly competitive electronics-missiles market.

Indications are that in the turbulent period ahead, many small and medium-size companies in these markets will fall by the wayside or be forced into mergers to survive because of increasing requirements for maintaining expensive capabilities.

According to the Ling-Temco management, the merger is an initial step aimed at maintaining two continuing phases of expansion and growth:

- **Strong research and development** team to fulfill the need of rounding out commercial and defense product lines.
- **Selective acquisitions** on a planned program basis to supplement both companies to form a major research and development and production group in the electronics and missile fields.

The proposed merger, to be submitted to the boards of directors and stockholders of both companies soon, tentatively provides that each Temco stockholder would receive 6/10 of a share of Ling-Temco Electronics, Inc., stock for each share of Temco and that Ling-Altec stockholders would get one share of Ling-Temco for each share of Ling-Altec. Current management and other personnel of both companies would be utilized in the new group, with proposed top executive positions as follows: Robert McCulloch, Temco Aircraft president becoming chairman of the board of Ling-Temco Electronics, Inc.; James Ling, Ling-Altec board chairman becoming vice chairman and chairman of the executive committee; Clyde Skeen, Temco executive vice president and general manager becoming president, and Lee D. Webster, Ling-Altec executive vice president, secretary and treasurer becoming Ling-Temco executive vice president.

NASA Agena Contract Slated for Lockheed

Washington—National Aeronautics and Space Administration is negotiating a $50 million contract with Lockheed Aircraft Corp. for 16 Agena-B upper stages for satellite and lunar probe launch vehicles.

Approximately half the 16 Agenas in this initial order are to be used with Thor boosters, the balance will be used with Atlas. First vehicle, an Atlas Agena-B, is scheduled to be launched in approximately one year, and delivery of the 16 Agenas is to be spread over the next three years.

Thor Agena-B will be used to launch earth satellites beginning late next year, including the Nimbus meteorological satellite which will follow the Tiros series. It will be capable of placing payloads weighing up to 1,500 lb. in earth orbits.

USAF Nozzle Plans

Washington—Air Force has asked industry for ideas on novel rocket engine nozzle designs in anticipation of a possible development program. Solicitation of information is being handled by the Edwards Rocket Engine Test Station at Air Force Flight Test Center, Edwards AFB, Calif.

Allies to Pool Efforts For NATO Aircraft

London—Top government officials of England, France and West Germany have reached an agreement to jointly develop and produce military aircraft and electronic components for NATO forces but suggestions that the British industry pool its know-how apparently do not have approval of the principal airframe and engine companies at present.

Cooperation agreement involves mainly two projects:

- **Development** of a vertical takeoff and land aircraft tailored to NATO requirements.
- **Production of electronic** equipment aimed at European air defense needs.

British manufacturers appear to be taking a "wait and see" attitude on the triangular agreements, pending a tentatively scheduled three-power meeting in London within the next six weeks. Some confusion exists: AVIATION WEEK has learned that Aviation Minister Duncan Sandys made no attempt to contact, or brief, British aircraft and electronic firms on his discussions with France and West Germany.

News Digest

Dr. August Raspet, Mississippi State University aerophysicist, and Lowell Meyers, of Chance Vought Aircraft Corp., were killed last week in a modified L-21 aircraft during a landing approach at Starkville, Miss. The L-21 was equipped with a suction type high lift boundary layer control system (AW Nov. 30, p. 59) pioneered by Raspet and his students at Mississippi State.

Sikorsky Aircraft has temporarily suspended flight operations of its HSS-2 twin-turbine helicopter pending a decision as to the cause of the Apr. 23 accident in which the rotorcraft crashed during a low-level high-speed run, killing experimental test pilot Francis Yirrell, copilot Gordon Hazell and engineer Harvey Hochman.

International Business Machines Corp. has been selected by Air Force for analysis and design study of Air Force Control System 473-L known as "Globe-Quick." System is an automatic data processing and display system intended to provide USAF headquarters with up-to-the-minute status of all its forces and facilities. In this respect, it resembles the Strategic Air Command Control System 465-L except that it will include data on all Air Force commands.

Boeing Airplane Co. has received a contract from Air Force Air Research and Development Command for a preliminary design for a recoverable booster system. The nine-month program will be under the direction of ARDC's Wright Air Development Division. Preliminary design work will be managed for Boeing by its engineering and product development organization within its Aero-Space Division.

Army Nike Zeus anti-ICBM test vehicle was successfully fired from an underground silo at the White Sands, N. M., Missile Range last week in the first attempt to launch the system from below ground. First-stage 45,000-lb.-thrust booster was ignited in the test firing; second stage and warhead were inert. Firing was the sixth launch of a Zeus test vehicle, of which four have been completely successful, according to Army spokesmen.

Hughes Aircraft and Minneapolis-Honeywell have been named by Navy as a second source for Polaris missile inertial guidance system, with Hughes building the digital computer and holding system responsibility and Minneapolis-Honeywell providing the gyro-stabilized platforms. Navy's action in establishing a second source may have been prompted by concern that General Electric, its primary Polaris guidance producer, is being threatened with a strike by the International Union of Electrical and Radio Workers.

Fairchild Engine & Airplane Corp. is discussing with Eastern Air Lines a possible order of as many as 30 F-27 transports powered by Rolls-Royce Dart R.Da. 10 turboprops rated at 2,660 eshp. each, compared with 1,960 eshp. each for the Dart Mk. 528s which power the F-27A. Eastern also is discussing new aircraft with other manufacturers.

Policy Shifts Expected From New CAB

Board members support Commerce study, suggest an overhaul of their regulatory approach.

By Robert H. Cook

Washington—Civil Aeronautics Board, virtually reorganized by the recent appointment of three new members, can be expected to scuttle a number of policies set by predecessor members, including that of awarding routes as a means of strengthening weak carriers.

An AVIATION WEEK poll of four of the present members indicates a near unanimous agreement on many philosophical points which provide some indication as to the direction the newly constituted Board can be expected to move during the next few critical years. At the same time, each member studiously avoided answering any questions which might tend to disclose their voting positions on cases presently pending before the Board.

Members interviewed by AVIATION WEEK were the new chairman, Whitney Gillilland, Vice Chairman Chan Gurney, new member Alan S. Boyd and veteran member G. Joseph Minetti. Former Chairman James R. Durfee has been appointed to the bench of the U.S. Court of Claims and is scheduled to leave the Board today. He will be replaced by a White House staff member, Maj. Gen. John S. Bragdon as predicted by AVIATION WEEK (AW Apr. 18, p. 25).

A West Point classmate of President Eisenhower, the 67-year-old general has served for almost six years as a special assistant on the presidential staff and will complete the remainder of Durfee's term which expires on Dec. 31. Bragdon withheld comments on the Board pending his full participation in CAB activities.

While airline spokesmen view the new makeup of CAB with mixed emotions, they agree that any change of policy probably will hinge largely upon the action Congress takes on Department of Commerce recommendations on national transportation needs (AW Mar. 21, p. 42) and, if accepted, the manner in which the proposals are implemented by the Board.

Generally, the four Board members interviewed by AVIATION WEEK gave strong support to major parts of the Commerce Department recommendations concerning awards and subsidy. They believe that, while it was necessary to nurture the infant airline industry for many years, the time has come for a re-evaluation of the carriers and CAB's policy toward them.

Long-term CAB policy toward the recommendations, however, could change if Bragdon's successor does not agree with the present Board thinking.

The Board members also feel that their own administrative and procedural practices should be reorganized in line with the accelerated pace of industry. They add, however, that, while criticism leveled at the Board last year by former member Louis J. Hector called attention to many problems, it failed to offer workable solutions.

Gillilland's Position

Chairman Gillilland, former chairman of the U.S. Foreign Claims Settlement Commission, feels strongly that the Board's authority should be clarified but does not support any further powers for CAB. He is an advocate of "learning to work with the tools Congress already had provided" and says that, as a practical matter, it would be extremely difficult for the Board to expand its present authority.

In particular, Gillilland sees a need for a closer look at the Board's past policy of adding new competition on domestic routes. He agrees with the Department of Commerce recommendations that call for the Board to halt any further awards of parallel route certifications where jet aircraft are involved until the impact of such service has been fully evaluated.

Past Board policy of promoting competition—in an era when there were fewer aircraft with smaller capacities—strengthened the domestic carriers, Gillilland believes. He adds, however, that conditions have now reached a point where the dangers of over-competition must be given careful consideration.

Heavy gains in the use of jet aircraft, plus industry progress and the eventual development of supersonic transports, Gillilland said, also have served to highlight the possibility of carrier mergers in the future. The chairman said he could take no stand on the Board's probable stand on merger petitions but added that he thinks CAB should carefully consider the merger possibilities of short haul airlines with duplicating route systems.

In the field of local-service operations, Gillilland foresees a gradual change in this type of airline as the CAB tightens its "use it or lose it" formula and trunk carriers drop many unproductive points which may be ideal for local service use.

On the question of whether the CAB should have more authority over international rate structures that are now established through International Air Transport Assn. traffic conferences, Gillilland feels the Board should have

WHITNEY GILLILLAND

JOHN S. BRAGDON

increased power in this area. He warns, however, that such authority should be used sparingly to minimize possible "countermoves" on fares and rates by foreign powers acting on behalf of their flag carriers.

A believer in first hand knowledge of the problem at hand, Gillilland feels that each Board member should be required to write his own opinions in final CAB decisions as opposed to the present practice whereby professional opinion writers usually perform the task. "I'd like to be sure," he said, "that when they sign their names to a decision, they fully understand the details of the subject."

Need for effectively coping with a variety of subjects encountered by the CAB also was emphasized by Gillilland, who suggested that this could be better accomplished by a seven-member Board split into two panels of three each, with the chairman acting primarily as an administrator. Each panel, along with the vote of the chairman, would cast the decisive votes on the issues at hand. Members would be rotated periodically between panels to gain the widest possible experience.

Based upon his past experience as a judge of the 15th Judicial District of Iowa, Gillilland says he finds merit in the present system of appointing Board members to a definite term of office as opposed to any proposals to make office a lifetime appointment. Knowledge that a member's reappointment will be at stake in the future should serve as a "prod" toward an active record.

Gurney Stand

Chan Gurney, vice chairman for the past three years and a Board member for eight years, also supports most of the Department of Commerce recommendations and emphasizes that "we can't continue to put multiple carriers over the same routes."

Terming the Commerce report "very effective," Gurney backs suggestions that the airlines be given every opportunity to attain sufficient financial stability to pay reasonable user charges. He agrees that a close watch should be kept on the government's mounting subsidy bill but adds that the value of local service operations to the public must be retained and are "worth the subsidy." Gurney also points out that one of CAB's basic responsibilities is to keep the airlines in a healthy condition so that they can be depended upon in times of national emergency.

On the matter of competition and future merger possibilities, Gurney said it is "meaningless" to put any airline on a route where there already is sufficient competition. While the growth of the airline industry and the attendant competition that continues to increase has made mergers a topic of serious discussion within the industry, Gurney warns that "we don't want one carrier way out in front to cover the whole field." While such a merger might be advantageous to the carriers involved, Gurney says the remaining competing airlines could find themselves financially unable to modernize their fleets, thus precluding any hopes of offering lower air fares.

Gurney points to the heavy investments of the airlines for new aircraft and the trunklines' independence from subsidy as practical proofs that the controversial rate of return formula applied by the Board for measuring the allowable profits of both trunk and local service carriers is justified. The formula has been attacked in the past by local service operators and smaller trunk carriers who favor a profit margin formula.

The vice chairman sees no particular advantage in either expanding CAB membership or increasing the terms of office, pointing out that it would be difficult to dislodge any member endowed with a permanent status.

As for the need of any further legislation providing a strict code of ethics for independent agency members, Gurney feels this is unnecessary and largely pointless. Several such bills are now pending in Congress.

Within the Board's present work procedures. Gurney admits it is a "battle" to find ways to expedite the backlog of cases on file but points out that many seemingly unproductive and time-consuming CAB steps are a direct result of the Board's responsibility to observe the rules of the Administrative Procedures Act.

Minetti's Views

G. Joseph Minetti, former member of the Federal Maritime Board, has two years remaining of his CAB term and has gained a reputation in the airline industry as a champion of low fares and a believer in the need to hold the line on subsidy payments.

His general philosophy follows a pattern of encouraging the best possible airline service at the least possible cost to the public and, as such, he favors mergers between trunk carriers as a desirable alternative to subsidy operations. Minetti has filed meticulously detailed dissents against any CAB majority orders which raise fares, impose surcharges, increase subsidy or hamper the expansion of charter flights.

With a background as assistant to three U. S. attorney generals in the Antitrust Division, he also watches for any possible antitrust violations in agreements between airlines. A demonstration of this stand is Minetti's dissent in the six-carrier Mutual Aid Pact, in which he opposed the majority approval. Referring to possible antitrust implications involved in the agreement designed to provide aid to strikebound carriers, Minetti said: "Such questions are always present where competitors agree to share excess earnings. Sharing profits with a competitor, like playing marbles 'for fun' rather than for 'keeps,'

ALAN S. BOYD

CHAN GURNEY

G. JOSEPH MINETTI

is entirely inconsistent with the concept of vigorous competition between rivals. The carriers have been certificated to compete with, not subsidize, each other."

Minetti's steadfast refusal to compromise his philosophy on this and other issues can be expected to play a decisive role in future Board decisions.

Alan S. Boyd, who was appointed to replace Louis J. Hector for the remainder of Hector's term which expires on Dec. 31, 1962, previously served as chairman of the Florida Railroad and Public Utilities Commission. The youngest of the CAB members, Boyd, 37, last week denounced the criticism of CAB by his predecessor at a meeting of the Great Lakes Conference of Railroad and Utilities Commissioners in White Sulphur Springs, W. Va.

He found some agreement, however, with Hector's charges that CAB's regulatory procedures are too lengthy and cited this lag as "possibly the Achilles' heel of the independent agency." Cause of the lag can be cured internally within the CAB, Boyd said, and stems primarily from failure to restrict the essential issues raised in airline applications, the desire to cover too much territory in investigations and procedural statutes which require public hearings on matters of small consequence and public interest.

While praising the Board for its handling of details and delegation of responsibilities to staff members, Boyd said there is still "room for improvement" in the further delegation of authority. The major reason staff members are not given more authority, he said, is the fear that they may "drop the agency into hot water." But he added that, although this could happen, "the importance of dealing adequately with major problems outweighs by far any temporary embarrassment or criticism that may occur as a result of a faux pas at the staff level."

Boyd considers the Commerce Department report as one whose over-all findings as "generally superficial" in that they "just seem to set forth preconceived notions."

He views CAB's past route award policy as one that upholds the Board's duty to promote vigorous competition between trunk carriers and as a necessary means of developing full market potential. At the same time, he feels that the Board should carefully scrutinize the daily flight patterns in many market areas to guard against adding any more competition that could result in diluting total revenues for all carriers concerned.

Boyd does not question IATA's role in setting international fares but says CAB should have "at least standby authority" to establish the rates and protect U.S. interests in the event that IATA drops this practice.

He also has strong opinions on the often lengthy and complex political maneuvering behind the award of air carrier permits to foreign airlines. He contends that sole criteria for such certificates should be based upon aviation economics and adds that such a course is necessary to stabilize the future of U.S. flag carriers. "There is no rhyme or reason to inject political implications into route awards," he says.

In considering the possible industry future, Boyd says a steady increase in the airlines' jet fleets, coupled with their rising operational costs, tends to indicate that the CAB can expect to face merger requests from some carriers or eventually consider a realignment of existing routes. For the local service airlines, he foresees a tightening of subsidy controls with an ultimate goal of tailoring subsidy payments to the needs of specific communities as opposed to the current practice of airline needs.

Boyd also believes in a broad exchange of experience between the respective members in all CAB issues, and, while he sees no advantage per se in increasing CAB's membership, he believes an expansion would give Board members the opportunity to gain experience in a greater number of fields. Were the CAB expanded, Boyd said he would favor assigning members primary fields of responsibility at the beginning of each year. Members could choose their desired fields of interest and rotate the duties each year to gain a maximum of experience, he said.

While granting permanent status to Board members would offer much in the way of security in attracting new members, Boyd feels such a move also might work to the disadvantage of the public and the industry by eliminating the "fresh thinking" injected into CAB through its set terms of office. Turnover of Board members also provides the added advantage of fostering an almost continuous re-evaluation of the developments of the entire membership or its respective members, Boyd said.

Another suggestion Boyd made for expansion of CAB's authority was the need to permit the Board to represent itself in court actions rather than having the Department of Justice involved. He also wants authority for CAB to levy assessments against carriers who violate CAB regulations. Present issuance of cease and desist orders amounts to little more than a "slap on the wrist," Boyd said, since the airlines are "already properly subdued" when the order is issued.

Boeing 727 Competition

Paris–Sud Aviation and Douglas Aircraft Co. are studying a new Caravelle version aimed at direct competition with the Boeing's three-engine 727. Called Caravelle XIV, the aircraft would use a Douglas-designed wing permitting a cruising speed of Mach .84. The aircraft would be powered by two Rolls-Royce RB 141-11A turbojets, developing 15,000 lb. thrust each and equipped with reversers and suppressors. Instead of carrying 85 tourist passengers as at present, the new version would haul 95 passengers. Maximum weight would be 104,000 lb. instead of present 90,000 lb. Full payload would be carried over 1,900 naut. mi.

Capital Fights to Stave Off Bankruptcy

New York–Three top Capital Airlines officials made a last-ditch effort last week to stave off bankruptcy of the company when they met with Vickers-Armstrongs' U.S. lawyers and financial advisers here to discuss the practicability of flying to England to meet with their British creditors who have petitioned for foreclosure of the airline (AW Apr. 18, p. 40).

At the same time, the airline appealed to the Civil Aeronautics Board for reconsideration of its original request for immediate subsidy relief which the Board had initially denied (AW Apr. 4, p. 47). Unless the Board grants the renewed plea for subsidy aid–which is considered unlikely–or unless some accord with British note holders is reached, Capital will go into bankruptcy.

As of late last week, the three officials–President David H. Baker, Senior Vice President Raymond Lochiel and Board Vice Chairman Charles Murchison–had received no response from London as to whether the proposed talks would be acceptable to the British. The top-level management drive to prevent the trunkline from failing was authorized by a board of directors decision last month.

Most observers feel the British creditors now want to see a reorganization in hopes that such a move would open the way for payment of the notes. In addition, it is known that the notes are insured but that claims under the insurance guarantees are payable only after creditors have "taken steps to minimize the loss."

It is believed here that the note

holders already have filed claims for the unpaid balance of about $33 million. Presumably, the court petition for foreclosure of the airline represents such steps.

About 85-90% of the outstanding notes are reportedly insured by the British government's Export Credit Guarantee Department. The organization was originally formed to encourage foreign trade through the guarantee of loans.

Vickers-Armstrongs, representing holders of the chattel mortgage notes that cover the loans used by Capital to purchase a fleet of 60 Vickers Viscount turboprop aircraft, filed a petition with a U. S. district court here to foreclose on the carrier's flight equipment and appoint a receiver to take over the property.

As matters now stand, Capital is operating at a critical cash level and is meeting current operating expenses only through deferral of interest and depreciation charges. Unless the airline can persuade the British to withdraw their foreclosure position, chances are strong that it will file for bankruptcy under Chapter 10 of the Federal Bankruptcy Act before May 8, date by which it must answer Vickers-Armstrongs' complaint.

Meanwhile, the Board has shown no sympathy for Capital's plight. In fact, in its order calling for an investigation of the airline (AW Apr. 25, p. 43), it used language that appeared to block any hope of the airline continuing to operate as it is now constituted. In addition to launching the investigation to determine the reasons for Capital's problems, here is what the Board wants to find out:

- **Whether "alteration, amendment,** modification or suspension in whole or part of any or all" of Capital's operating certificates is required.
- **Whether the "transfer** of any or all of the routes of Capital to another carrier or carriers would be in the public interest . . .
- **"Whether the integration** of the routes of Capital and another carrier or carriers into a unified system by means of merger, consolidation, acquisition of control, route transfer or in any other lawful manner would be in the public interest . . .
- **"What other remedial actions** would be in the public interest and in accordance with the public convenience and necessity and should be taken by the Board [or Capital] to rectify the present situation."

The language of the order thus appears to indicate that the Board already has decided that dismemberment of the airline's system lies as the basic solution to Capital's problems. In addition, there is no indication that the Board will rescue the carrier from its critical situation by granting it temporary subsidy which it crucially needs at once.

The Board order reads almost as though it were a direct response to statements made by Capital's President Baker at the annual stockholders' meeting last month. At this time, Baker charged that Capital's route structure is a "creature" of the CAB and added that the "CAB must accept its share for the carrier's unprofitability."

In giving its reasons for ordering the investigation of Capital, the Board said the airline had been awarded routes it sought in a series of cases on the belief that the CAB's decisions "were responsive in substantial measure to Capital's asserted need for route strengthening and would result in significantly improving its financial condition."

In another instance, the Board said it awarded Capital "substantial additional routes in the Great Lakes-Southeast Case "in an effort, in part, to bolster Capital's economic health."

The Board also noted that Capital had failed to develop coach service to the same extent as other comparable carriers and pointed out that, although the airline has the shortest average passenger haul of any trunkline, "its average flight stage length, an equally significant economic figure is . . . longer than that of five trunks, shorter than five others and the same as one."

France Enters Supersonic Transport Race

Paris—Sud Aviation, builder of the Caravelle and France's major state-owned airframe company, has teamed up with Avions Dassault, an important private airframe company, to develop jointly a supersonic medium-range airliner, the Super-Caravelle Sud-Dassault.

Agreement between the two companies also calls for joint development of a twin-turboprop liaison aircraft designed both for civil and military use in France's overseas communities. Both companies already are flying prototypes of aircraft in this category.

Sud-Dassault agreement, before going into effect, requires government approval. In fact, both projects will require considerable amounts of government money. The "marriage" between the companies, said a Sud official, depends on the government putting up the dowry.

In announcing their agreement, Sud and Dassault officials gave few details on their proposed supersonic medium-range airliner. They said it would fly in the Mach 2.2 region, have a range of 2,500 mi. and that the first prototype might be in the air by 1964. Configuration and powerplants still have to be determined. Georges Hereil, Sud president, said the group would use the best engines available, including British or American versions.

Immediate reaction of industry observers was more of puzzlement than of approval. It was thought unlikely the government would agree to pump money into a supersonic medium-range airliner program at the present time.

French Civil Aviation Ministry already has helped to finance the present Caravelle subsonic airliner in its various versions, some of which will not be flying for a few years. Thus it appeared Sud might be risking cutting the ground out from under its future subsonic Caravelle projects by announcing, as the joint communique put it, a rapid development of a supersonic medium-range airliner.

Moreover, many French observers wonder about the market possibilities for a supersonic medium-range jetliner. They claim it doesn't make sense to operate supersonic aircraft between, say, Paris and London. In any case, French government authorities, before committing themselves, have asked a private transport organization, Air Transport Institute (ITA), to study the problems of supersonic transport.

Observers in the French industry also question the possibilities of the second part of the Sud-Dassault agreement, dealing with joint development of a twin-turboprop liaison aircraft. An aircraft of this type admittedly has an established market waiting for it throughout the French African community.

Both Sud and Dassault have developed competing twin-turboprops which could be used in this market. Both are powered by Turbomeca Bastan turboprops of 750 hp. Sud's entry is the Diplomate with a military version called the Voltigeur (Scout) (AW Apr. 18, p. 71). Dassault's entry is the Communaute, called the Spirale in its military designation (AW Apr. 25, p. 25).

Both these aircraft, however, were designed primarily to meet military needs in Algeria. As liaison aircraft they carry only 10 to 14 passengers. Many observers claim this capacity is inadequate to meet air transport demands between French African nations. Thus if Sud and Dassault seriously intend to tap this market they apparently will have to strengthen their present liaison prototypes.

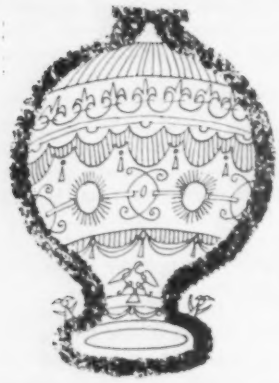
Yet if they do this they will be developing an aircraft competitive with the Max Holste Super Broussard. This aircraft hauls 23 passengers and is also powered by two Turbomeca Bastan turboprops (AW Jan. 25, p. 87). Since the Super Broussard has been developed with the aid of the government, few industry observers expect the government to turn around and finance an aircraft which would be largely competitive with the Super Broussard.

A BRIEF

HISTOIRE D'AIR FRANCE

(that is also a history of French aviation)

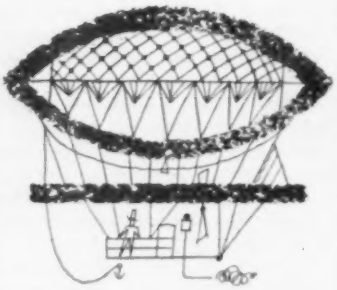
L'HISTOIRE ANCIENNE

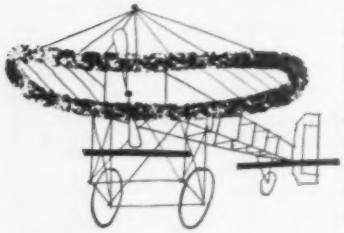


FIRST MEN TO FLY. Joseph and Etienne Montgolfier successfully take to the skies, June 5, 1783. Man's ancient dream of air-borne travel suddenly becomes a practical reality.

L'HISTOIRE "PIONEER"

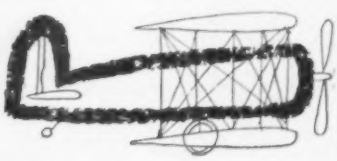
FIRST ENGINE-POWERED DIRIGIBLE. Remarkable speed of 6½ MPH was clocked by Henri Gifford on a Paris-Trappe flight, September 24, 1852. An early demonstration of the French genius for technical achievement that is a tradition with Air France today.



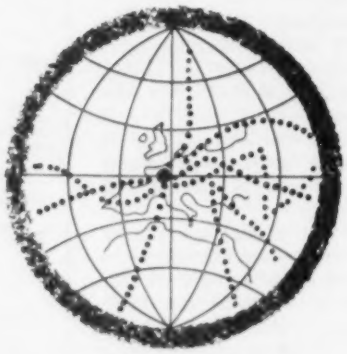


FIRST INTERNATIONAL FLIGHT. French aviation gained new stature when Louis Blériot flew 25 miles across the English Channel, July 25, 1909. This memorable journey focused world attention on the immense possibilities of commercial flight.

FIRST INTERNATIONAL PASSENGER FLIGHT. Air France's flight from Paris to London, February 8, 1919. Eleven passengers made the trip. Flew 187 miles in 2½ hours. Today, Air France passengers fly 1500 miles in the same 2½ hours.



L'HISTOIRE MODERNE



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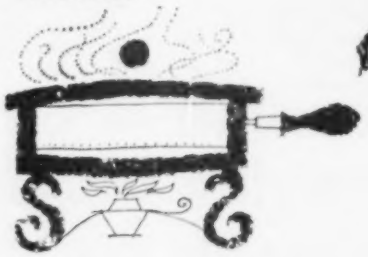
LES PLUS GRANDS JETS. All Air France jets are superb! The 707 Intercontinentals are the largest, fastest, longest-range jets in the world. Air France Caravelle Jets have an outstanding performance record. Air France uses both to provide the world's only jet-to-jet service between the U.S.A., Europe, Africa and the Middle East.



LE PLUS GRAND SERVICE. Air France service is incredibly lavish, incomparably French. On every flight, passengers enjoy superb French cuisine, exquisite French service at no extra cost. Experienced Air France pilots are experts at providing smooth, restful flights. They have flown more than 5,000,000 pure jet passenger miles.

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Airlines Streamline Turbojet Maintenance

By David H. Hoffman

New York—Major U.S. carriers, with up to 20 months of turbojet operating experience now behind them, are gearing overhaul and maintenance procedures to match the speed and efficiency of their jet transport fleets.

The impact of the jets is quickening the pace of maintenance at all levels and is best reflected by the International Business Machines Co. parts control systems, X-ray inspection equipment and private line telephone nets being installed in the larger airlines' hangars.

Streamlining of maintenance is paying off in increased aircraft utilization rates, which last year climbed steadily, partially offsetting the decline in load factors experienced by American Airlines, Pan American World Airways and Trans World Airlines—most experienced U.S. jet carriers in terms of air-miles flown. This decline ranged from 10 to 30%.

Jet utilization rates, pegged at about 6.75 hr. per day during the phase-in period, have risen to an industry average of over 8 hr. TWA flew its Boeing 707-320 fleet 8.9 hr. daily in March and averaged 8 hr. daily utilization on its 707-120s. Through Feb. 26, Continental Air Lines achieved a peak airline utilization rate of 10.21 hr. on its four 707-120s and now is scheduling its jets for 12 hr. daily.

Nevertheless, the high cost of jet maintenance is cutting into the inherent productivity of the jet transport—a productivity that measures 85,204 seat-miles per hour for the Boeing 707-120 as compared with 29,096 seat-miles per hour for the Douglas DC-7C.

Boeing 707 service was inaugurated by Pan American on Oct. 26, 1958, by American on Jan. 25, 1959, and by TWA on Mar. 20, 1959. Through the middle of April, these three carriers had logged about 55,155 hr., 57,100 hr. and 48,000 hr. respectively on their 707 fleets. Their combined total of 160,255 flight hours represents about 85% of all Boeing 707 airframe hours flown in commercial service. Now in their second year of maintaining the transport, they are agreeing that:

• **Size of the 707** coupled with the need to keep it airborne results in maintenance costs per flight hour that are almost double those for Douglas DC-7s or Lockheed 1649s. Tight scheduling plus the absence of spare line aircraft has required 24-hr. maintenance capability and has forced the carriers to hire and train more mechanics in order to assign more to a given malfunction. Pan American, near the end of its first jet year, estimated that 707 maintenance costs per flight hour were about 50% higher than forecast and about triple those of the DC-7C.

• **Trend toward consolidating** jet overhaul at large bases is being accelerated. With jets accounting for about 40% of its total revenue passenger miles, American is concentrating jet overhaul operations at its Tulsa, Okla., plant. Pan American, with jets accounting for 50% of its passenger miles, is doing the same thing in New York. TWA is using its Kansas City facility for jet overhaul.

• **Cost of system** and airframe components, often five times greater than the comparable parts of DC-7 or 1649, is resulting in a more precise provisioning of spares and the cutting of pipeline times whenever possible. Data processing controls systems now being installed by TWA and by United Air Lines will pinpoint high usage parts and keep track of part rejection and failure rates.

Formal parts pooling arrangements have been concluded between American, Pan American and TWA. Parts borrowing was about 200% more prevalent in 1959 than in 1958, according to TWA, which lent 492 components to American, Pan American and Continental Air Lines, while borrowing 201. Despite a rise in the dollar value of inventories, the numerical ratio of spare parts stocked for each engine and airframe has not changed significantly since the introduction of the jets.

• **Complexity of highly automated** subsystems on the 707 and the relative novelty of its turbine engines has led to a greater emphasis on specialty training for maintenance personnel. It also has resulted in private telephone networks that link the carriers' en route stations with minor maintenance capability to the carriers' prime sources of maintenance know-how. When TWA takes delivery of its Convair 880s, a drop telephone from its PLF system will be installed in the Convair plant at Ft. Worth.

TWA also has instituted the "specialty foreman" concept in its maintenance organization, training mechanics to be experts in particular systems and scheduling them in around-the-clock shifts at overhaul and support bases. Pan American has found that while more maintenance manpower is consumed by the jets, it can be apportioned by function—to electronic, engine, metal and instrument repair, for example—in the same ratios required by piston aircraft.

On the 707 airframe, carriers are resorting to ultrasonic sound and X-ray inspection wherever practicable. Structural breaks in the jet airframe are more difficult to locate and repair because the widespread use of honeycomb construction rules out visual inspections.

Most patching of the 707 skin must be flush in order to keep drag, a major cost item, at a minimum. This necessitates removal of large sections of sheet metal covering for, instead of overlaying patches, mechanics now must apply them to the skin's undersurface. Because of the 707's cabin pressure—8.25 psi. maximum as compared with 5.5 psi. maximum on the Super G Constellation—fuselage patches and repairs also must be stronger.

The rash of aircraft system and engine accessory troubles that plagued the jets during their first year of operation rapidly are being eliminated. In retrospect, these malfunctions appear less serious than the comparable ones encountered by the major piston-engine transports shortly after their introduction.

A major trouble source, however, has been the 707's water injection system. Nearing the end of its first jet year, American estimated that 20 to 25% of ground delays were attributable to water system malfunctions.

The water system consists of two pumps, each of which feeds two engines on the same side of the aircraft. Failure of either pump on takeoff cuts all water to one side, resulting in pronounced yaw as thrust abruptly decreases. The required fix is a costly retrofit that probably won't be undertaken.

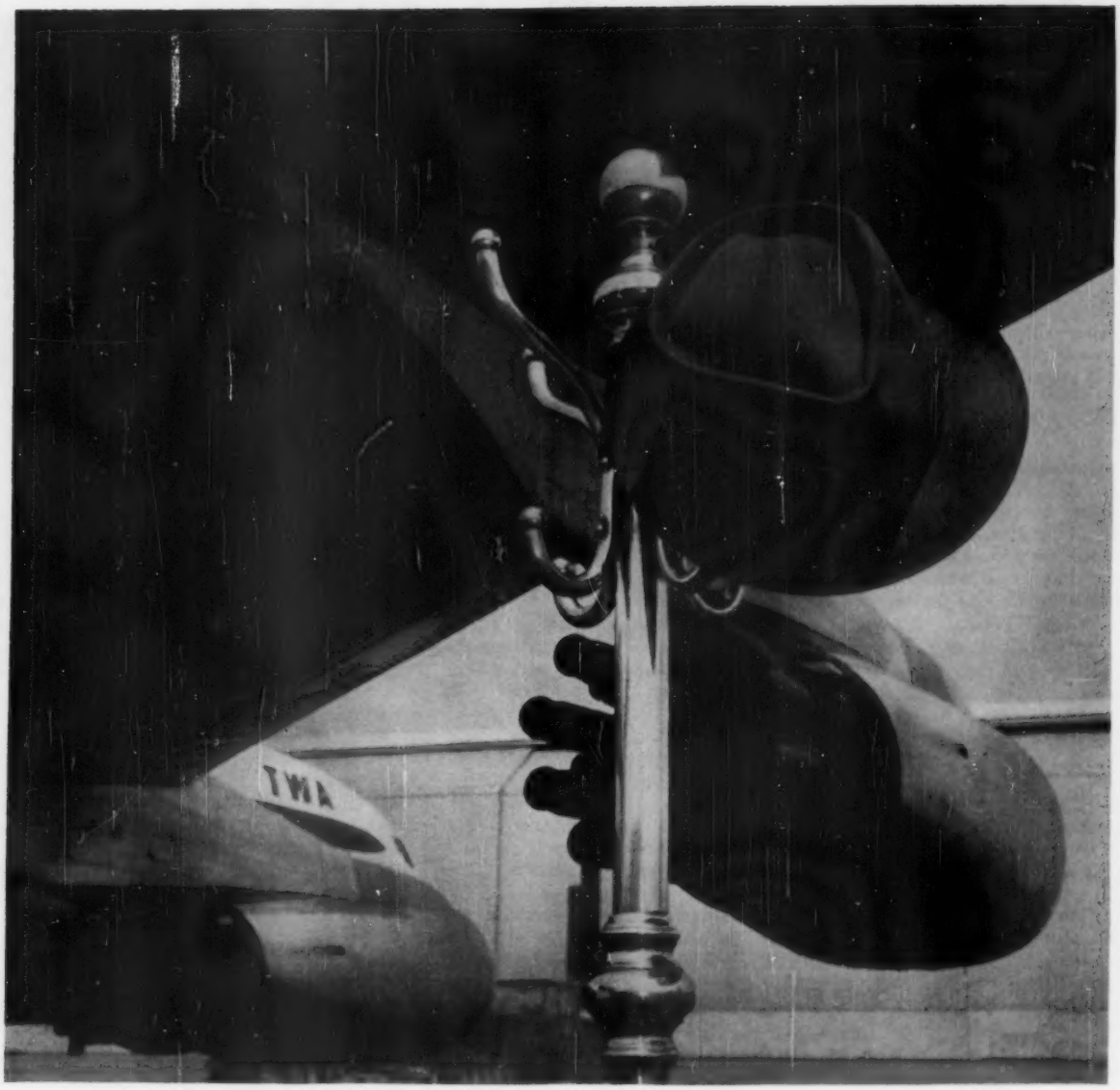
As a compromise improvement, however, jet operators have rerouted the 707-120 drain lines that formerly froze during the dumping of residual water. Installation of heavier lines and improved seals also has helped to stop connection point leakage. But low life expectancy of the submerged, electrically-driven water pumps still remains as an important flaw in the system.

Continental's Costs

Continental Air Lines reports that the direct plane-mile cost of operating its Boeing 707-120s during 1959 was $1.57. Comparable figure for the carrier's Douglas DC-7B fleet was $1.65.

With four 707-120s accounting for 56% of its total revenue passenger miles in 1959, Continental also listed a direct seat-mile cost of $1.44 for the jets and $2.07 for the DC-7Bs. Totally allocated break-even load factor for the 707s was 42.5% in 1959.

Continental, which also operates a fleet of 15 Viscount 810 series turboprop transports, was flying about 81% of its daily seat miles in turbine-powered equipment at the end of 1959.



Where a Texaco Engineer hangs his hat

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Fuel gage irregularities, half-charged starter bottles, surging hydraulic pumps, hydraulic system leaks (responsible for a majority of 707 unscheduled landings), stuck stabilizer trim controls and erratic compass transmitters no longer constitute major system problems.

A series of fixes in the 707-120 and 707-320 hydraulic systems alleviated pressure in the pump casing primarily through a relief valve installed in the crossover line. New filters have isolated the over-all contamination of the system experienced after seal failure. But miscellaneous leaks throughout the system continue, on occasion, to drain off large quantities of hydraulic fluid, depriving the pumps of lubrication.

False fire warnings, poor ground air conditioning, the dumping of passenger oxygen masks into the cabin by the cabin pressure auto sensor and frozen lavatory drains are other flaws being reported by pilots.

Discussing these points at the Air Transport Assn. Engineering and Maintenance Conference last October, R. M. Adams, maintenance manager for Pan American's Atlantic Division, said: "... You might understand that the design of the exhaust pressure ratio transmitter didn't properly account for environmental sonic energy. So it falls apart at a fraction of its intended life. But you remember enough years of winter operation to hope that space-age designers would realize that water freezes at 32F. But, the lavatory water drains freeze up on this airplane, and the experiences we've had with the engine water injection system have caused the use of more colorful language than many of our hardened ramp agents had ever heard."

Pratt & Whitney's JT3 and JT4 engines, which on Apr. 1 had logged about 785,000 hr. in commercial carrier service, are compiling records of reliability that still amaze airline officials.

On the JT3, American has experienced one in-flight shutdown for every 29,316 hr. of engine operation. The comparable rate for Pratt & Whitney's R2800 engine, used by American for 13 years, is one shutdown per 2,430 hr. Of the R2800s removed prematurely, American has found that 24% were reparable.

Prematurely removed JT3s were 85% reparable.

In 1959, Pan American logged an average of 12,900 JT3 engine hours in between in-flight shutdowns. The carrier, as of Apr. 1 and after 106,000 hr. of JT3 operation, had not experienced a single failure attributable to basic engine components. With the R3350 engine used on the DC-7C, however, Pan American reported one engine shutdown for every 1,313 hr. logged and one basic failure for every 3,000 hr. logged during 1959.

United, after its first 35,000 hr. of engine operation, and Continental, after its first 41,000 hr., had not experienced a single basic JT3 failure. As of Apr. 1 and after 60,000 hr. of engine operation, United reported one basic failure plus three premature removals.

Maintenance man-hours required to overhaul the JT3s and JT4s are averaging 900 to 1,100 for the basic engine plus 500 to 700 hr. for the engine power package. The R2800, by contrast, can be overhauled in about 450 hr.

The cost of overhauling a JT3 averages about $12,000 when performed by the carriers and somewhat lower when performed by Pratt & Whitney. The first overhaul costs of R2800s and JT3s, Pratt & Whitney told AVIATION WEEK, are almost the same.

Although the cost of overhaul has proven lower than its original estimates, Pratt & Whitney said that maintenance man-hour requirements have been higher. Routine overhaul problems have been aggravated by the carriers' insistence upon increasingly higher power settings in the face of heightened competition, the manufacturer reported.

Another difference between airline piston and turbine engine maintenance procedures lies in the frequency with which the jet engines are removed from the aircraft during the time between overhauls. A JT3 with a time between overhaul of 800 hr., for example, usually is removed five or more times for periodic inspections prior to overhaul. Cylinder and accessory repairs and inspections of the R3350 and R2800, whenever possible, are performed on the aircraft by removing sections of the nacelle.

Even after three and four overhauls, the turbine engine does not suffer power deterioration to the extent that aging piston engines do. Turbojet fuel consumption, however, does creep upward after several overhauls.

First stage turbine seal erosion caused by the blast effect of small bicarbon particles that form on the JT3 fuel nozzles probably is the engine's prime problem of recent months. The installation of swirl vanes to disrupt blast airflow has been proposed as a fix by using airlines.

A second complaint voiced by many airline maintenance departments is that the authorized time between overhauls (TBOs) on the JT3 and JT4 engines is being extended far too slowly by the Federal Aviation Agency in view of the powerplants' proven reliability. These times are now fixed between 800 hr. and 1,000 hr. for U. S. operators of the engines.

Two approaches have been used by the airlines to boost their TBOs. Under the "reliability method," the FAA may grant a 100-hr. TBO extension if 90% of a carrier's engines reaching overhaul maturity within a given three months prove to be structurally sound. The second approach involves a series of joint FAA-airline inspections leading to the same result.

But last November, in a move aimed at standardizing the procedure for extending TBOs, the FAA presented the carriers with a formula that would have hinged TBO extensions on the frequency of engine failures experienced by a given airline. This formula was received coldly by carrier engineers who argued that it lacked flexibility. Rather than use the formula to increase engine overhaul times, the airlines elected to stay at current TBOs while drafting a compromise proposal for FAA consideration. Last month, representatives of American, Braniff, TWA, Continental and Pan American met for this purpose with FAA officials in Washington.

In a typcial TBO evolution of the JT3, TWA began operating the engine at 800 hr. in March, 1959. Last August, the carrier was granted a 100-hr. extension, followed by a second 100-hr. extension in January, 1960, that brought TWA's authorized TBO on the engine to 1,000 hr.

Airline officials maintain that this so-called "escalator" rate, which has averaged about 200 hr. a year on recently developed powerplants, is only adequate for piston engines. The allowable TBOs on British turbine engines, one official told AVIATION WEEK, are increasing at rates of up to 750 hr. a year.

Meanwhile, the airlines are provisioning spare engines in about the same proportion for 707s as for DC-7s and Super Constellations. But as new aircraft are purchased and some engines are irreparably damaged, this ratio is expected to decrease, especially if the FAA steps up the pace of TBO extension.

Component Cost Comparison

	707-120	L-1649
Elevator with tabs	$29,833	$3,000
Outboard wing flap	11,818	5,606
Inboard wing flap	22,357	6,886
Generator (JT3 or JT4)	2,150	570
Outboard aileron	17,334	none
Single aileron		4,053
Carburetor (fuel control unit)	7,100	2,019
Main cabin door (L-1649) or forward entrance door (707)	16,107	2,100
Brake assembly	793	550

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NORTHEAST AIRLINES

Long-Haul Load Factors Face Decline

By Glenn Garrison

New York—Influx of new jet capacity in the transcontinental airline markets is expected by fall of this year to make itself felt on load factors which still are running high on the blue-ribbon long range routes.

Total seat capacity on the nonstop runs between the east and west coasts and between Chicago and the West Coast was less last year than in 1958, largely because United Air Lines had retrenched while waiting for delivery of its Douglas DC-8 jet aircraft. But with the new summer schedules effective Apr. 24, almost all of which are jet, capacity is higher than ever and the peaks won't come until later this year and in 1961. Factors affecting the 1960 picture on these highly competitive routes include:

• **United** is back in the fight with DC-8s on the New York-Los Angeles, New York-San Francisco, Washington-San Francisco, Chicago-Los Angeles and Chicago-San Francisco routes. The carrier has received 24 of 40 DC-8s on order and will be adding schedules as more airplanes are delivered.

• **Continental Airlines** has bought and received delivery of a fifth Boeing 707-120, which it had optioned, and the airplane will go into service this month. Continental began jet service last June and now is one of four jet operators on the Chicago-Los Angeles run.

• **American** is operating in the New York-San Francisco nonstop market, which it entered last fall after bitter opposition from TWA and United, the other two operators on the route, both of which also serve it with jets.

• **Several** carriers will soon be getting the first units of second-round jet orders. United and American are scheduled to receive Boeing 720s within the next couple of months. Trans World Airlines is receiving its first Convair 880s. Some of these airplanes probably will take over routes now served by the longer-range jets, freeing the latter for transcontinental service.

Daily Nonstop Capacity

As of the Apr. 24 nonstop schedules, about 4,940 seats in each direction will be offered by the four carriers serving these routes. This total compares with 3,669 at the same time last year and 4,450 at that point in pre-jet 1958. The 1960 breakdown is New York-Los Angeles, 1,023 seats; New York-San Francisco, 676 seats; Chicago-Los Angeles, 1,509 seats; Chicago-San Francisco, 878 seats; Boston-Los Angeles, 118 seats; Philadelphia-Los Angeles, 111 seats, Washington-Los Angeles, 347 seats; Washington-San Francisco, 220 seats, and Detroit-Los Angeles, 58 seats.

Thus far, jets to a large extent merely have replaced piston capacity on the transcontinental routes. The jets, it is generally agreed, also are generating new traffic of themselves. But the high-nineties load factors experienced by American and TWA when they opened jet service early last year are probably gone forever.

The competitive squeeze will be felt particularly on such routes as Chicago-Los Angeles, where daily jet round-trip nonstop schedules later this month will total 16, divided among American, Continental, United and TWA.

Load factors in multiple-competition markets such as this are bound to go down, R. E. Johnson, United's senior vice president-sales and advertising told Aviation Week. United presently is offering fewer jet seats in the Chicago-Los Angeles market than it offered piston seats in 1958, Johnson pointed out. The carrier's load factor at mid-April in this market was running about 76% for all jet flights in both directions, he said.

Competitive Markets

Another market in which Johnson feels there is too much duplication is New York-San Francisco. United's approach, he said, will be to schedule "realistically" so that capacity is kept in reasonable proportion to load factors even in the most competitive situations. The airline's jet loads so far have been good: at mid-April, load factors were running 84% Chicago-San Francisco, about 73% New York-San Francisco, about 69% New York-Los Angeles.

The transcontinental market, in Johnson's view, increasingly is being affected by another factor: the polar route services. These West Coast-Europe flights divert considerable traffic which otherwise would move transcontinentally to and from the East Coast gateways, Johnson said.

United has just entered another West Coast market with DC-8 service, flying a nonstop Chicago-Portland schedule which goes on to Seattle, and a New York-Chicago-Seattle schedule which goes on to Portland. The New York-Seattle market may be another critical one, Johnson said, when Northwest gets its DC-8 equipment on the route. Northwest is scheduled to receive its first jets this summer.

Another DC-8 schedule which United expects to begin this month is Chicago-Denver, where Continental has been enjoying sole proprietorship of jet service.

Continental, which entered the Chicago-Los Angeles market only three years ago, admits it must fight to survive the competition and has attacked the market aggressively. By May 16 it will be offering eight daily round trips between Chicago and Los Angeles, five of them nonstop, for a total of more than 1,000 seats a day. But, as one of the carrier's officials put it, Continental faces a "David and Goliath" situation in many respects. When the competitive squeeze is on, the other three carriers, being more favorably established in the market, may fare somewhat better with their load factors, Continental admits. But the airline feels it has an advantage in its break-even Chicago-Los Angeles load factor, which it says is 42.5% to cover totally allocated overhead expenses.

Jet Utilization

Continental's jet utilization is 12 hr. daily and with the new schedules, will go to 12 hr. 45 min. The ratio of Continental's indirect to direct costs is 87 cents to $1, according to the airline. Being smaller and more flexible, Continental can get along with less overhead in the supervisory area, it says.

Continental's first-quarter 1960 report showed a profit, with sales up 75% over 1959 (see p. 26). For the period of 1959 during which it operated jets, the airline's jet load factor was 60%, which produced a profit.

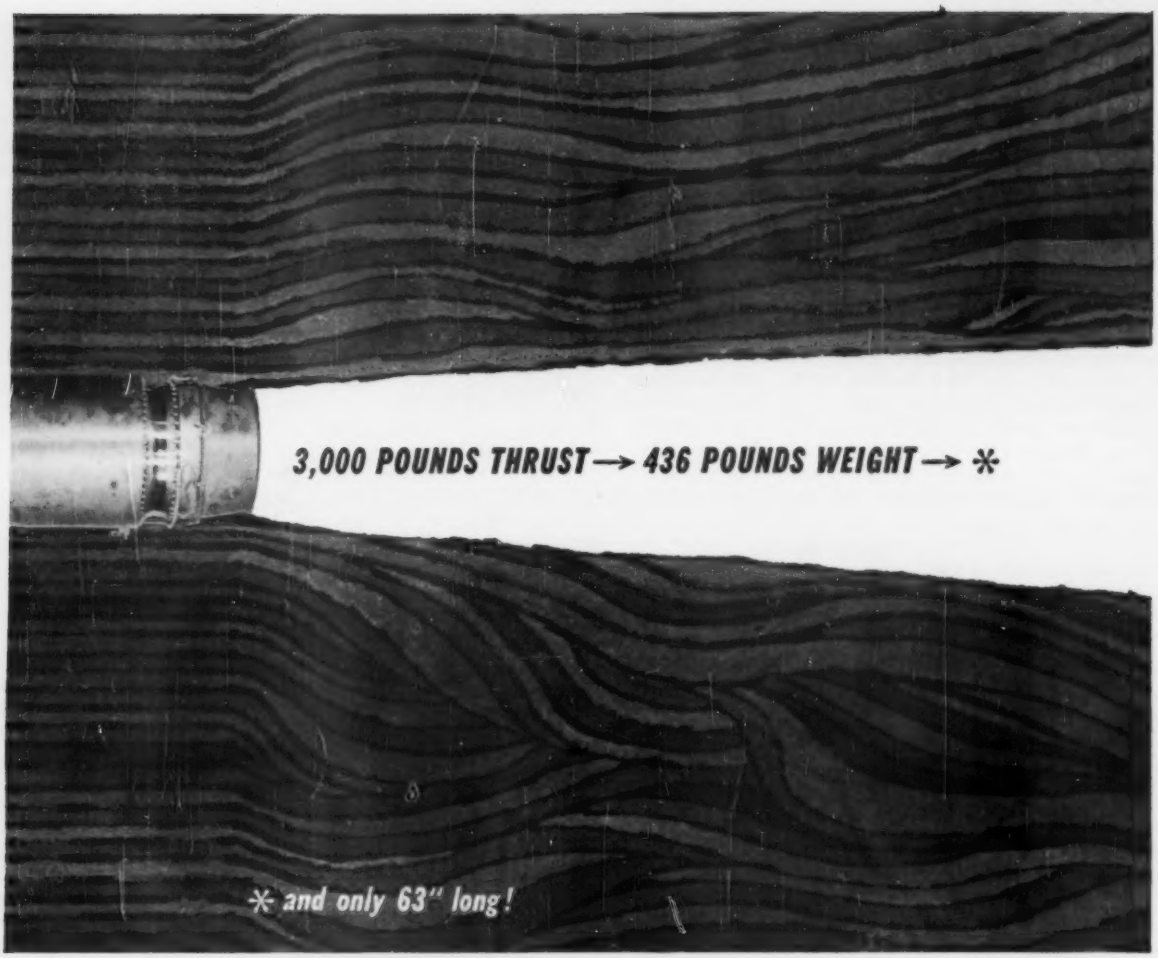
Continental's approach will be to "keep offering the most jet seats." It

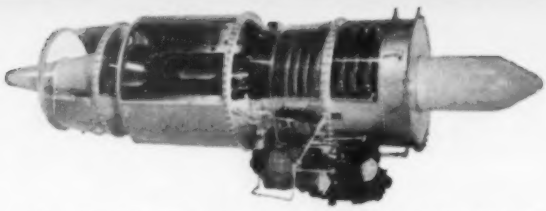
ALPA Weighs Appeal

Chicago—The Air Line Pilots Assn. late last week was considering an appeal to the U. S. Supreme Court as the fourth legal challenge of a series aimed at setting aside Federal Aviation Agency's order grounding airline pilots at the age of 60.

An ALPA spokesman here told Aviation Week that attorneys for the association still were studying the U. S. Court of Appeals decision Apr. 21 upholding the FAA age limitation. In March, ALPA had sought to bar enforcement of the retirement regulation in U. S. District Court (AW Feb. 29, p. 47).

Hours after this decision had been filed by the District Court, ALPA asked the Court of Appeals to reverse it. The appellate court, after refusing the association's petition, declared that ALPA could restate its case before a three-judge tribunal.





New Pratt & Whitney Aircraft JT12 jet engine is built around proven design concepts for high thrust to weight ratio, ruggedness, reliability and low maintenance.

The JT12 delivers heavyweight thrust in comparison to the light weight of the engine itself. At maximum cruising speed the thrust specific fuel consumption is only .890. A new jet engine designed on a proven principle, the JT12 is an axial-flow, medium-pressure-ratio turbojet. Behind the JT12 stands all the research, manufacturing and testing facilities that produced the renowned Pratt & Whitney Aircraft J-57 and J-75 designs—the new standards of aircraft engine reliability in commercial jet transportation. Because of the sound basic design of the JT12 and its relatively simple construction, it's an outstandingly reliable and easily maintained engine. The JT12 now powers such aircraft as the Lockheed JetStar transport, the North American Sabreliner and the Canadair CL-41 military trainers, and two U. S. Army drones. Today, the JT12 is establishing new flight performance records of its own.

PRATT & WHITNEY AIRCRAFT
East Hartford, Connecticut
A DIVISION OF UNITED AIRCRAFT CORPORATION

believes the Chicago-Los Angeles market can support four carriers. The airline took a 28.3% share of that market in the third quarter of 1959 and 26.8% in fourth quarter 1959, and estimates it got at least 25% during the first quarter of this year. It expects to gross $60 million in 1960, compared with $46 million in 1959.

Other favorable factors Continental points to in its operation are high on time performance and short turnarounds--basically 1 hr. in Chicago and 1½ hr. at Los Angeles. Schedules call for 30 min. on the ground at Denver for through flights.

Continental says it has 60% of the Chicago-Denver market, but it shortly will be facing United's DC-8s, and possibly TWA's 880s on this route.

No merger talks between Continental and anybody else are under way or contemplated, a spokesman said.

American's Schedules

In the Chicago-Los Angeles market, American is offering four daily nonstops under the new schedules, a total of 472 seats, up from 402 last year. American introduced, along with the new schedules, a new configuration of its 707-120s on all routes, boosting capacity from 112 to 118 seats by adding 18 coach seats and taking out 12 first class seats.

American's seat capacity on the transcontinental and Chicago-West Coast nonstop routes is up 47% this year to 1,770 daily seats each way, all of them jet. At the time summer schedules went in last year, the carrier was offering 649 piston seats and 560 jet seats over the routes. Total passenger miles over the New York-Los Angeles, Washington-Los Angeles, Chicago-Los Angeles and Chicago-San Francisco routes has increased more than 30% over this time last year. Approximate over-all load factor over the same routes was above 70% this year, compared with a load factor in the high 60s last year in both piston and jet equipment. On its new nonstop route between New York and San Francisco, American is offering 236 daily seats each way.

American agrees with United that these markets are going to be highly selective by fall. Careful scheduling will be required and adjustments made. American notes, however, that jets have increased traffic on the routes.

TWA, which entered jets into the transcontinental market last March, offers 1,293 nonstop seats under the new schedules, up from 1,064 seats at this time last year. The airline's nonstop capacity on the routes is all-jet except for a 72-seat piston schedule in the Chicago-Los Angeles market. Its total capacity in this market is 294 seats—like United, less than it offered in piston aircraft in 1958. TWA is offering 333 seats New York-Los Angeles; 222 seats New York-San Francisco; 111 seats Chicago-San Francisco; and one 111-seat round trip a day over its Washington-Los Angeles, Washington-San Francisco, and Philadelphia-Los Angeles routes.

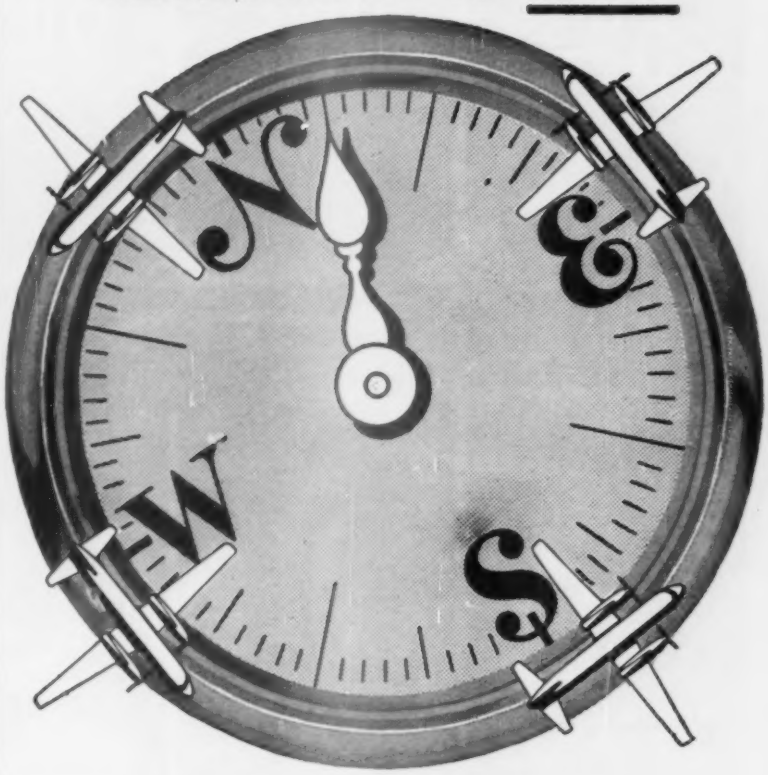
Jet Seat Mileage

The airline's daily 1959 jet seat mileage as of Apr. 24 was 1,549,560 and piston seat mileage was 4,248,696. This year, the totals are 6,314,418 jet seat miles and 806,004 piston seat miles over these nonstop routes.

Some indication of load factor trends during 1959 on the transcontinental routes may be had from a quarterly comparison of jet load factors systemwide, because much of the jet capacity was on the transcontinental segments. American's first quarter result was 94%; second quarter, 93%; third quarter, 87%; fourth quarter, 75%. TWA's jet load factors (domestic) were first quarter, 94%; second quarter, 75%; third quarter, 90%; fourth quarter, 75%.

Continental's second quarter load factor was 83%; third quarter, 63%; fourth quarter, 55%. United reported an 89% jet load factor for the third quarter and 74% for the fourth quarter.

ALLEGHENY IS SURE



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Legislative Action on Airport Noise May Follow West Coast Hearings

Los Angeles, Calif.—Possibility of legislative intercession in the airport noise problem has been raised by a tour of the Transportation and Aeronautics Subcommittee of the House Committee on Interstate and Foreign Commerce which heard noise complaints and arguments here after similar hearings in San Francisco.

Some aviation leaders have warned for several years that uninformed laymen would intervene if industry experts failed to solve the noise problem.

Suggestions by civic groups protesting jet noise included:

- **Removal of jet operations** from Los Angeles International Airport, now in the midst of a $70 million-plus development program, to an airport in the outlying desert.
- **Withdrawal by Congress** of quasi-legislative powers now held by executive agencies such as Civil Aeronautics Board and Federal Aviation Agency.
- **Creation of a special** federal commission responsible for the effects of aircraft upon people and property on the ground.
- **Reorganization of FAA** to give it dual chiefs, one with responsibility for aircraft in flight and one with responsibility for the effects upon people below.
- **Setting up a congressional** watchdog committee to monitor operation of FAA and guarantee civil rights of residents near airports against intrusion by jet aircraft operators.
- **Reduction of payloads** by fiat to cut required takeoff power and noise levels.
- **Elimination of takeoffs** to the east from Los Angeles International to prevent discomfort and hazard to the dense population underlying the eastward climb-out.
- **Allocation of funds** to FAA for a continuing survey of jet approach and departure techniques at Los Angeles International, aimed at finding which airlines and pilots offend most and least and then codifying successful techniques.
- **Appropriation of money** for a national noise suppressor development program.
- **Conversion** of Los Angeles International into a city park.

Francis T. Fox, general manager of the Los Angeles Department of Airports, testified that it would cost between $200 million and $300 million to duplicate International's airport facilities elsewhere. Locations suggested by some speakers were Palmdale, 75 mi. north, and Ontario, 40 mi. east. Fox said the airport logs about 1,000 flight operations daily and is a terminal for six foreign and 13 domestic airlines.

One witness claimed that monorail transit could get passengers from one of the desert airports to Los Angeles centers in no more time than that required by limousine service from International. But Don Belding, president of the Los Angeles Board of Airport Commissioners, said French experience indicates a monorail system would cost $3.5 million per mile.

It was suggested that cargo operations might be turned away from International to keep the problem from worsening with the advent of jet cargo aircraft. Belding said the airport commissioners had considered using Van Nuys Airport in the San Fernando Valley, but no decision was reached. Industry studies show that cargo traffic tends to move at night so that goods will arrive in the early morning for the opening of the business day. This also is the period when people are most sensitive to noise.

Airport authorities cited eight measures they have taken to abate the noise nuisance:

- **Jet transport pilots** were requested to fly a little high on the instrument approach glide slope.
- **Field regulation** was established requiring pilots departing on runways 25L and 25R to climb out on a course clear of the beach community of Playa Del Rey, crossing the beach at a minimum altitude of 1,500 ft. A rotating beacon was set up at the north end of the clear zone to give pilots a reference point for night takeoffs.
- **Runway wind instruments** were installed at the east and west ends of the airport to give control tower operators a better measure of the relative safety of easterly and westerly takeoffs. With less than a 10 kt. tail wind, takeoffs are possible to the west over a comparatively clear area.
- **Instrument glide slope** was raised from 2.75 deg. to 3 deg., permitting aircraft to make final approaches at a slightly lower power setting and slightly higher altitude over heavily populated communities.
- **Instrument approach procedure** was altered so that incoming aircraft intercept the glide slope at an altitude of 3,000 ft. instead of 1,700 ft. Aside from the noise reduction caused by flying at a higher altitude during much of the approach, the change enables pilots to stabilize their power settings earlier, without radical changes at low altitude.
- **Airlines were required** to use exhaust and inlet noise suppressors for all engine runup testing between 10 p.m. and 7 a.m.
- **Runway 25L** is being extended from 10,000 ft. to 12,000 ft. to make possible westward takeoffs in strong easterly winds, allow pilots to make steeper final approaches and permit them to land farther from the airport boundary.
- **Night takeoffs** to the east were prohibited except in east winds over 10 kt.

Speakers for the community of Inglewood, east of the field, noted that FAA in effect canceled the ban on night takeoffs to the east in passing Special Regulation 438 without including it. The regulation as proposed by the regional FAA office had included the ban.

FAA, CAB Maintain Positions on Electra

Washington—Congressional efforts to mediate a safety controversy between the Federal Aviation Agency and the Civil Aeronautics Board over the airworthiness of the Lockheed Electra turboprop transport failed last week as both agencies issued conflicting statements reaffirming their previous stands.

Board Chairman James R. Durfee and FAA Administrator Elwood R. Quesada appeared before a special session of the Senate Commerce Committee to determine why CAB recommended grounding of the aircraft on Apr. 12, while FAA permitted them to fly with speed restrictions, pending a joint testing of the aircraft by Lockheed Aircraft Co. and the FAA. CAB's statement also announced that an operational hearing on the Tell City crash will be held in Evansville, Ind., on May 10.

Neither agency altered its previous position as a result of the meeting. The Board said all five members had concurred in requesting the grounding of the Electra "until the necessary inspection and repairs" could be made. The Board statement said basis of the recommendation was crash investigation evidence uncovered by CAB teams at two Electra accidents at Buffalo, Tex., last September and Tell City, Ind., in March. An earlier letter from Durfee to Quesada attributed the request to deficient wing tabs found on some Electras (AW Apr. 25, p. 40).

FAA, charged with the responsibility of certificating the aircraft, said that a final inspection completion of 112 Electras by the airlines, plus their operation under two FAA-imposed speed reductions, dropping their speed to 225 kt., gives the Electra a structural margin of safety that is "as great, if not greater than" that of any other commercial airliner.

AIRLINE OBSERVER

▶ Reed committee suggestion that MATS could meet its immediate airlift needs by acquiring a fleet of Canadair CL-44s is under serious Air Force study. Reed report pointed out that CL-44s could be obtained through a production sharing exchange in which U.S. combat aircraft—possibly the F-101 or F-105—would be traded to Canada. Reed committee—headed by Gordon W. Reed, chairman of the board of Texas Gulf Producing Co.—was appointed by USAF to determine the most practical means of realigning MATS operations to provide more revenues for commercial carriers (AW Apr. 18, p. 39).

▶ Soviet Tu-124 turbojet transport is believed to be the prototype of Russia's first supersonic transport design. Aircraft was rolled out in December. First version is a small aircraft with a seating configuration of about 50-60 seats. Flight test program for the aircraft, which is powered by four turbojet engines designed by Soloviev, is now under way. Soviets began flying the aircraft at the earliest possible date to enable them to build, within a relatively short time, larger models based upon the performance data obtained from the typical Soviet long-term flight test program with the prototype.

▶ Supersonic transport team of the Federal Aviation Agency, organized Mar. 7 to study and analyze problems associated with high speed commercial operations (see p. 60), has completed basic talks with major segments of industry and Air Force branches as a first step toward laying the groundwork for full studies. Team is headed by Col. Harrison Thyng.

▶ Issues at stake in the Civil Aeronautics Board's New York Short-Haul Coach Investigation have drawn sharp battle lines between the Board and the airlines involved in the case. During the hearings, which were recessed Feb. 4 and are scheduled to be resumed today, trunklines have been unanimous in their protests against Examiner Paul N. Pfeiffer's apparent effort to push additional coach service in short-haul markets, particularly on the New York-Washington route. Airlines were strong in their stand against arguments that such service would generate new traffic. Now the Board's bureau counsel has gone one step farther in behalf of the CAB position. It proposes an investigation to determine the desirability of a no-frill, economy-type service between New York and Washington at fares lower than existing coach rates.

▶ Airline stocks listed on the New York Stock Exchange again sank to new lows last week in a market that has been registering substantial declines. On one occasion, as many as six of the 10 domestic trunklines listed on the exchange, plus Pan American, hit new 1960 lows.

▶ Eastern Air Lines plans to withdraw a total of 35 piston-engine transports from its fleet of 235 planes in accordance with normal summer schedule cutbacks. Seat miles will be reduced about 10% from peak winter season level. Eastern is now operating 45 turbine-powered aircraft in scheduled service.

▶ Federal Aviation Agency has awarded General Instrument Corp. a $7.6 million contract for 38 radar bright display systems. Delivery is scheduled to begin in April, 1961. FAA now has 10 air route traffic control centers and four airport control towers equipped with radar bright display equipment.

▶ Aeroflot's most popular and frequently scheduled service—the 55-min. Moscow-Leningrad run with the 100-passenger Tu-104B turbojet transports—will be expanded to as many as 15 round-trip flights daily this summer. During the first year of the Tu-104B operations on the routes, beginning in April, 1959, Aeroflot made 1,700 round trips with a load factor of close to 100%. Soviet officials are complaining that the biggest problem on the short-haul flights is that, at Leningrad, it often takes longer to unload the plane and distribute the baggage than it does to make the flight.

▶ Bilateral talks between State Department and the Philippines, Mexico and Great Britain began in Washington last week. Demands for new route concessions are expected to be made by each of the three countries. Philippines negotiations will be based on its plan to resume transpacific service.

SHORTLINES

▶ **Civil Aeronautics Board** has denied a Slick Airways request for permission to operate a maximum of four flights per month from Tokyo to San Francisco or Los Angeles for Japan Air Lines for a 10-month period ending in September. In its order, the Board said the Slick petition did not constitute operation of cargo flights for JAL on an occasional, emergency basis as granted Slick in a previous temporary order. Pan American World Airways and Northwest Airlines filed objections to the petition.

▶ **Federal Aviation Agency** has certificated the Convair 540 turboprop-powered transport for commercial service. The aircraft are being converted from conventional piston engines to Allison 501-D13 turboprop engines by Pac-Aero, a subsidiary of Pacific Airmotive Corp. A total of 16 Allison-powered Convair 540s have been sold to date. Lake Central Airlines has ordered five with options on 10 additional airliners. Several corporations have contracted for 11 other Allison powered 540s.

▶ **Pan American-Grace Airways** is scheduled to begin Douglas DC-8 turbojet service from Miami to Panama, Lima and Buenos Aires tomorrow on a twice-a-week basis. Present daily Douglas DC-7C schedules will be maintained.

▶ **Pan American World Airways** reports its first quarter transatlantic freight figures were 50% above those for the same period of last year. Eastbound volume rose 37.3%; westbound by 66.5%.

▶ **Scandinavian Airlines System** is scheduled to begin Douglas DC-8 turbojet service between New York and Copenhagen this week. Initially, the service will be operated on a four days per week basis, with the frequency rising to daily on May 8.

▶ **Trans-Canada Air Lines** has contracted for three more Vickers Vanguards, making a total of 23 of the four-engine turboprop transports ordered by the Canadian airline (see p. 123). First Vanguard will be delivered to TCA in September; others will follow at the rate of one per month. Vanguard, fitted with Rolls-Royce Tyne R.Ty.11 turboprops, will be in 96-passenger configuration and will be flown on TCA's domestic routes, trans-border routes to United States, and the West Indies.

▶ **United Air Lines** is scheduled to begin Douglas DC-8 turbojet service into Denver on May 25, with daily nonstop service to Los Angeles and Chicago. The Chicago flight will continue on to New York.

Starts June 1

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Vintage Champagne. Gourmet Cuisine.

COACH
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WESTERN AIRLINES

Dollars Per Total Aircraft Hour

	FLYING OPERATIONS					DIRECT MAINTENANCE				FLYING OPERATIONS AND DIRECT MAINTENANCE	DEPRECIATION AND RENTALS	TOTAL DIRECT EXPENSE
	CREW EXPENSES	FUEL, OIL & TAXES	INSURANCE	OTHER EXPENSES	TOTAL	AIRFRAMES	ENGINES	OTHER FLIGHT EQUIPMENT	TOTAL			
707'S												
AMERICAN	95 35	214 67	79 20	0 05	389 27	49 12	67 82	7 06	124 00	513 27	201 98	715 25
BRANIFF	107 32	251 21	131 32	0 55	490 40	187 12	166 16	12 67	365 95	856 35	209 31	1,065 66
CONTINENTAL	76 94	224 82	64 08	....	365 84	52 01	126 42	4 17	182 60	548 44	111 47	659 91
NATIONAL	86 92	248 77	32 04	0 06	367 79	.....	.....	.....	.....	367 79	803 92	1,171 71
NORTHEAST	73 28	....	128 23	....	201 51	.....	.....	.....	.....	201 51	1,039 68	1,241 19
TWA—100 SERIES	117 95	209 27	66 99	0 71	394 92	62 50	154 50	9 23	226 23	621 15	323 89	945 04
TWA—300 SERIES	156 37	205 22	75 54	0 50	437 63	106 42	247 38	21 01	374 81	812 44	377 35	1,189 79
PAN AM—100 SERIES	136 33	286 28	80 89	7 82	511 32	73 12	114 87	52 30	240 29	751 61	222 21	973 82
PAN AM—300 SERIES	209 11	316 22	72 48	0 31	598 12	64 39	80 83	13 97	159 19	757 31	328 86	1,086 17
DC-8'S												
DELTA	95 02	255 84	124 33	....	475 21	87 72	128 16	4 26	220 14	695 35	310 36	1,005 71
UNITED	93 92	156 47	142 77	11 37	404 53	73 31	20 32	21 85	115 48	520 01	190 15	710 16
ELECTRA'S												
AMERICAN	80 33	79 65	21 76	0 05	181 79	24 21	66 77	10 22	101 20	282 99	144 68	427 67
BRANIFF	64 76	70 79	24 09	0 35	159 99	29 56	85 43	8 37	123 36	283 35	83 77	367 12
EASTERN	70 04	76 06	10 35	(0 03)	156 42	30 47	56 60	17 88	104 95	261 37	120 88	382 25
NATIONAL	70 33	75 00	23 74	0 01	169 08	15 46	28 12	9 75	53 33	222 41	109 05	331 46
NORTHWEST	82 01	81 21	9 78	0 83	173 83	17 05	12 79	6 37	36 21	210 04	99 78	309 82
WESTERN	70 94	72 41	24 04	....	167 39	18 80	64 34	10 52	93 66	261 05	130 02	391 07
VISCOUNT'S												
CAPITAL	55 46	54 32	4 13	0 01	113 92	29 31	19 53	3 99	52 83	166 75	45 22	211 97
CONTINENTAL	50 17	57 57	11 88	....	119 62	25 33	42 48	5 20	73 01	192 63	53 56	246 19
NORTHEAST	42 00	53 79	17 61	0 09	113 49	22 34	18 21	8 73	49 48	162 97	59 31	222 28
SEABOARD (Year Ending Sept. 30, 1959)			....	....	.....	.....	.....	.....	.....	.....	160 63	160 63
ELAND CONVAIR												
ALLEGHENY	52 33	49 38	20 81	0 18	122 70	7 60	65 91	2 68	76 19	198 89	50 92	249 81
F-27'S												
ALOHA	28 69	38 80	11 41	0 01	78 91	(4 76)	17 24	2 28	14 76	93 67	26 91	120 58
BONANZA	36 83	32 39	11 95	0 41	81 58	22 93	38 50	5 88	67 33	148 91	26 36	175 27
NORTH. CONSOLIDATED	48 36	66 92	26 86	1 43	143 57	.....	.....	.....	77 71	221 28	44 58	265 86
PACIFIC	35 80	32 40	15 84	1 89	85 93	15 65	33 39	7 96	59 00	144 93	27 99	172 92
PIEDMONT	40 95	34 38	13 08	0 01	88 42	30 62	28 77	5 03	64 42	152 84	36 86	189 70
WEST COAST	39 39	38 39	11 75	0 11	89 64	32 51	34 24	8 17	74 92	164 56	32 65	197 21
WIEN ALASKA	41 26	63 45	32 09	0 84	137 64	.....	.....	.....	27 88	165 52	36 92	202 44

Turbine-Powered Aircraft 1959 Operating Expense

(Data supplied by Ray & Ray, Washington, D.C.)

Averages By Types

Cents Per Available Ton Mile

TYPE	FLYING OPERATIONS	DIRECT MAINTENANCE	DEPRECIATION AND RENTALS	TOTAL DIRECT EXPENSE
707'S	6.26	2.61	3.80	12.67
DC-8'S	9.46	3.28	5.04	17.78
ELECTRAS	5.50	3.27	4.12	12.89
VISCOUNTS	8.89	4.29	3.75	16.93
ELAND CONVAIR	53	5.92	3.96	19.41
F-27'S	13.72	9.37	4.92	28.01

Cents Per Revenue Aircraft Mile

	FLYING OPERATIONS	DIRECT MAINTENANCE	SUBTOTAL	DEPRECIATION AND RENTALS	TOTAL DIRECT EXPENSE
707'S					
AMERICAN	91 65	29 20	120 85	47 56	168 41
BRANIFF	104 38	77 90	182 28	44 55	226 83
CONTINENTAL	88 03	43 94	131 97	26 82	158 79
NATIONAL	81 91	.....	81 91	179 04	260 95
NORTHEAST	58 15	.....	58 15	300 00	358 15
TWA—100 SERIES	84 69	48 51	133 20	69 46	202 66
TWA—300 SERIES	94 63	81 04	175 67	81 59	257 26
PAN AM—100 SERIES	112 12	52 69	164 81	48 72	213 53
PAN AM—300 SERIES	123 87	32 97	156 84	68 11	224 95
DC-8'S					
DELTA	114 15	52 88	167 03	74 55	241 58
UNITED	140 38	40 07	180 45	65 99	246 44
ELECTRA'S					
AMERICAN	58 18	32 39	90 57	46 31	136 88
BRANIFF	48 31	37 24	85 55	25 29	110 84
EASTERN	50 17	33 66	83 83	38 77	122 60
NATIONAL	57 75	18 22	75 97	37 25	113 92
NORTHWEST	50 41	10 50	60 91	28 94	89 85
WESTERN	54 73	30 62	85 35	42 51	127 86
VISCOUNTS					
CAPITAL	46 81	21 71	68 52	18 58	87 10
CONTINENTAL	45 93	28 03	73 96	20 56	94 52
NORTHEAST	51 55	22 47	74 02	26 94	100 96
SEABOARD (Year Ending Sept. 30, 1959)			.....	121 15	121 15
ELAND CONVAIR					
ALLEGHENY	54 83	34 05	88 88	22 75	111 63
F-27'S					
ALOHA	45 67	8 54	54 21	15 57	69 78
BONANZA	41 39	34 33	75 92	13 44	89 36
NORTH. CONSOLIDATED	69 51	37 63	107 14	21 58	128 72
PACIFIC	44 30	30 41	74 71	14 43	89 14
PIEDMONT	46 75	34 06	80 81	19 49	100 30
WEST COAST	49 34	41 24	90 58	17 97	108 55
WIEN ALASKA	64 41	13 05	77 46	17 28	94 74

Air Union Sets Final Organization Details

By Edith Walford

Geneva—Final details of the Air Union agreement which will form the basis of the four-airline partnership in Europe are expected to be settled in a Paris meeting scheduled for Wednesday and Thursday.

Government and officials and representatives of the airlines involved—Air France, Germany's Lufthansa, Belgium's Sabena and Italy's Alitalia—will attend this final meeting.

One result of the Common Market Treaty signed in January, 1957, and implemented a year later was to induce some key industries in the six countries to take a closer look at their own positions within its framework.

Five leading European airlines began thinking about the advantages a future pooling of interests would offer. Air France, Alitalia, Sabena, KLM Royal Dutch Airlines and Lufthansa took a decisive step toward consolidating mutual interests and formed EUROPAIR, the organization within which they decided to pool future operations.

On Nov. 8, 1957, Lufthansa's chairman, Hans M. Bongers, outlined in a memorandum to each of the other four airlines the basic considerations he proposed to govern the envisaged partnership. The air traffic potential of each airline, index figure based on number of inhabitants in their respective home countries and their national product, share in world trade and international traffic were the chief considerations.

In April the following year, KLM discussed with Lufthansa the advisability of merging the two airlines.

Talks Resumed

The International Air Transport Assn. conference held in New Delhi Oct. 27-31, 1958, offered the next chance for some EUROPAIR members to resume talks. These resulted in Sabena, already planning an exchange of equipment with KLM, declaring its willingness to go along with the other three airlines as well.

Both KLM and Sabena informed Lufthansa on Dec. 12, 1958, of their decision to develop a mutual sales, materials and traffic policy and asked the German airline to join in with them.

Joint talks held in Brussels on Dec. 29, 1958, led to the establishment there of EUROPAIR's Economic Committee.

Second five-partner meeting was held in Paris Feb. 28, 1959, unanimous agreement was reached on these points:

- **EUROPAIR members** agree to cooperate for a period of 99 years.
- **Internal colony-to-colony** air traffic will be subject to the same cabotage agreements that apply for traffic between colonies and their home countries.
- **Joint traffic** will be shared on the basis of total ton miles flown, each airline receiving a certain quota. Air France, Sabena and Lufthansa agree to the quotas of 29, 9 and 26% of total respectively, already allotted.

Third meeting of the five airlines took place in Rome on Apr. 1-2, 1959. This dealt with additional problems such as the apportioning of revenue and of capacity output in percentage terms. An effort was also made to agree on the fixing of these proportions which would automatically remove the main issue affecting each of the individual airlines.

Early in the discussions, it was realized that this question was crucial because the final agreement would have to cover a number of years and must include an estimate of the ratio of expansion for some of the companies as well as other expected changes within the group over the agreed period.

Basic Principles

Agreement also was reached in Rome on four more basic principles:

- **All partners** agreed to pool sales.
- **Partners agreed** to develop EUROPAIR in every way possible.
- **Output of each company's** personnel working with EUROPAIR to be increased to the utmost.
- **Remuneration of personnel** to be based on cost of living in the respective country where staff is employed.
- **Five-partner agreement** is required on the quotas finally allotted.

At this stage in the Rome discussions, KLM proposed to first settle all the questions regarding the structure of the new organization, its method of accounting, traffic problems, voting and the introduction of a progressive scale to enable each airline's quota to be determined based on its share of total traffic.

Proposal Rejected

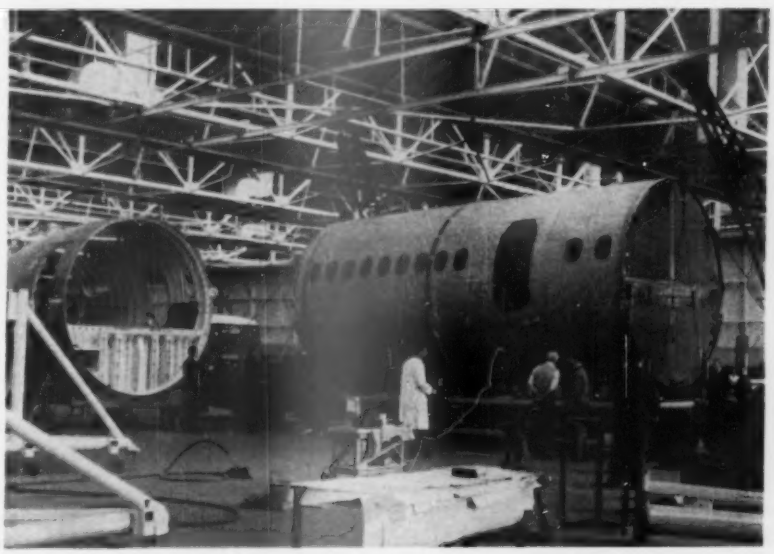
When the five partners met again for further talks at The Hague Apr. 27, 1959, Air France, Alitalia, Lufthansa and Sabena jointly rejected KLM's proposal and KLM resigned from EUROPAIR.

The four remaining members assembled on May 5, 1959. First item on the agenda was the redistribution of quotas following KLM's resignation. Air France was allotted 34%, Lufthansa 30, Alitalia 26 and Sabena 10.

Simultaneously, the designation EUROPAIR was changed to Air Union to eliminate any political flavor the former might have.

In addition, the following principles were agreed:

- **Establishment of a common sales,**



DH-121 Fuselage Section Completed

Fuselage section of the de Havilland DH-121 turbojet transport is prepared for mating with the aircraft's nose section (AW Apr. 11, p. 50). Other major components are being built by Fairey Aviation and Hunting Aircraft. Aircraft will make its first flight by the end of 1961.

COLLINS specially equipped Convair is flying actual flight demonstrations of the Collins Doppler Radar Navigation System. Navigation is completely independent of ground based aids. Collins Doppler provides precise ground speed, drift, course deviation, and distance to go anywhere in the world.

Flight Reports on Collins Doppler

Leading airline personnel, airframe manufacturers, and business aircraft owners saw the Collins Doppler Navigation System in action.

The Collins self-contained Doppler Navigation System made its command performances on January 18-25, 1960, following 3 years of extensive laboratory and flight tests.

On the afternoon of January 19 executives of the Forest Oil Company, Tennessee Gas, Continental Oil, Brown and Root Company, and the Union Oil Company took off from Houston Airport aboard a specially equipped Collins Convair. Navigation was solely by Collins Doppler.

The course followed was Houston to San Angelo to San Antonio to Houston at altitudes of 6,500 to 12,500 ft. The system automatically charted the path and planned the turns over intermediate destinations. Nowhere in this flight did the along track or cross track errors exceed 0.5%.

Demonstrations were conducted for executives of the Cheveron Oil Co., Sun Oil Co., Gulf Oil Co., California Co., TACA, and the New Orleans Aviation Board on January 20, 1960. Course flown — New Orleans to Birmingham and return at altitudes of 12,500 to 14,800 ft. A 0.33% along track error and a 1.5% cross track error was noted. On the flight from New Orleans to Birmingham, along track and cross track errors averaged 0.9%. On the return flight with automatic transfer between stages occurring at Meridian, along track and cross track errors averaged 1%.

A course was plotted to locate—navigating by Doppler—an off shore oil well rig 110 nautical miles out in the Gulf of Mexico. The Collins Convair flew at 600 ft. above the water. At the time the distance to go read zero-zero, the 20 ft. square oil rig was observed directly ahead of the nose of the Convair.

The personnel of Lockheed Aircraft Corporation attended the January 21 Doppler demonstration on a course from Atlanta to Louisville to Knoxville and back to Atlanta. The flight from Atlanta to Louisville was made at higher altitudes of 20,500 ft. at the request of the Lockheed executives. Extra descents from 20,500 to 13,000 ft. and climbs back to 20,500 ft. were made.

At the request of Lockheed's flight test personnel, the Doppler Convair executed sustained banks to the right and left while descending at the rate of 3,000 ft. per minute. This extreme test caused no deterioration in performance. At the end of the 2-way aerobatic flight across three states, no errors due to these maneuvers were noted.

Personnel of Delta, Southern Airlines Inc., Southern Airway Co., U.S. Steel and the Harbart Construction Company flew the same demonstration course on the afternoon of January 21. An along track error of 1.4% and a cross track error of 0.6% was noted on the flight from Atlanta to Louisville. On the return flight from Louisville to Knoxville to Atlanta, an along track error of 0.95% and a cross track error of 0.5% was noted.

TWA saw Collins Doppler in action on January 25. Course flown — Kansas City to Little Rock to Fayetteville and back to Kansas City at altitudes of 9,000 to 12,500 ft. On the leg from Kansas City to Little Rock, the along track error was 1.5% while the cross track error was 0.33%. On the Little Rock to Fayetteville to Kansas City flight segment, a cross track error of 1.5% was recorded with absolutely no along track error. In this "take-off to touch-down" demonstration, the distance-to-go read zero-zero upon landing at Kansas City.

These demonstrations offer convincing proof of the remarkable accuracy offered by the new Collins Doppler Radar Navigation System. Always performing to required ARINC specifications, no other commercial production Doppler system is consistently demonstrating such advanced performance and reliability.

Write Aviation Sales, Collins Radio Company, Cedar Rapids, Iowa, for complete information about Doppler Navigation. Ask for a flight demonstration in your area to see Collins Doppler in action under your flight conditions.

COLLINS

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA
DALLAS, TEXAS • BURBANK, CALIFORNIA

Artist's Conception of New Las Vegas Airport

Artist's conception of Las Vegas, Nev., municipal airport shows finger system connected with main passenger terminal at center. Clark County voters have approved a $5 million bond issue for construction. Work on the ramp complex is now under way. Passenger activities will be centered on second floor of the terminal; airport complex includes construction of a new control tower.

traffic and materials policy.

• **Any other airline** wishing to join Air Union should not be prevented from doing so.

• **Unanimous vote** of original members is required for the admission of new members.

• **Air Union** will operate independently of the Common Market.

• **Executive Committe** is formed to watch over terms of the agreement and to supervise activities of Air Union's planning, sales, technical and traffic sub-departments.

Meanwhile, executives to head Air Union's Executive Committee and subdivisions have been appointed from representatives of the four participating airlines. The governing body of Air Union is made up of chairmen and presidents of the new organization. J. L. Rattier of Air France is head of the planning department; J. M. Amirault, also of Air France, is general secretary. Coordinating chairman is Gilbert Perier of Sabena.

Sub-departments are headed by: M. H. de Villeneuve of Air France, economics department; Col. V. Reinero of Alitalia, ground traffic department; Dr. Günther Becher of Lufthansa, management and finance; Helmut Alt of Lufthansa, air traffic department; R. Cappelletti of Alitalia, department for international relations; F. Pirson of Sabena, equipment department, and G.

for '60

Lake Central Airlines starts its second decade of service in the Great Lakes-Ohio River Valley area by taking a giant step into the jet age—ordering five Allison Prop-Jet Convairs for delivery starting in late summer, 1960.

Lake Central's Board of Directors has also taken an option on 10 additional Prop-Jet Convairs from General Motors' Allison Division—a move promising continued improvement in passenger service for years to come.

When these 350-m.p.h. airliners enter service, Lake Central will offer its passengers the fastest scheduled local airline service in America.

The line's passengers will travel in planes which are far quieter, more vibration-free and more comfortable than any piston-powered airliners serving other local carriers.

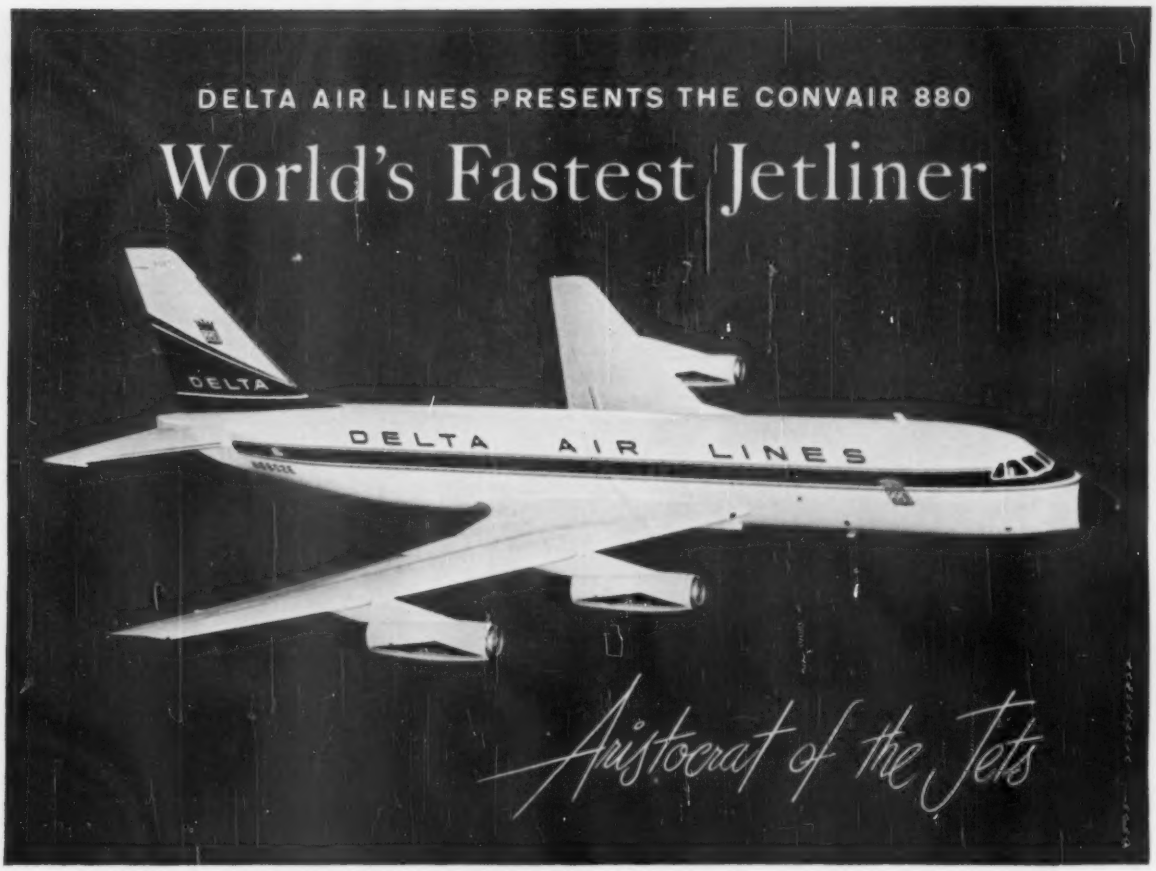
And they'll ride in fully pressurized, completely air-conditioned 52-passenger aircraft that will get them to their local destinations far sooner, far more rested and relaxed than ever before.

An airline is as good as its service to passengers—and Lake Central is making certain its service is the best.

LAKE CENTRAL AIRLINES

DELTA AIR LINES PRESENTS THE CONVAIR 880

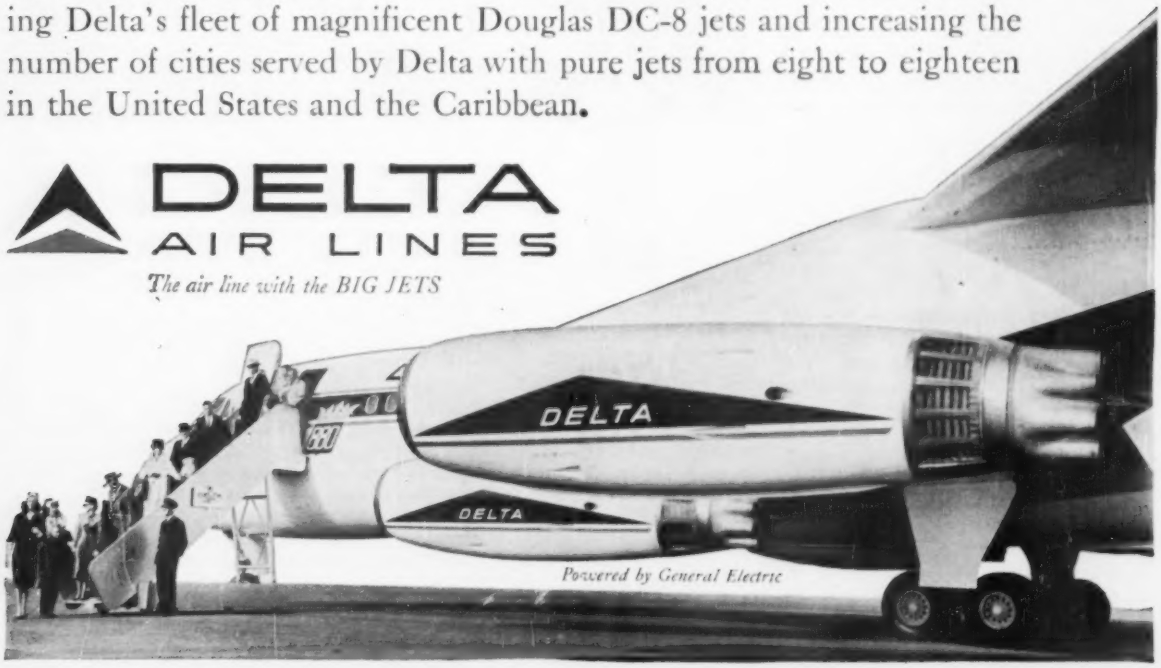
World's Fastest Jetliner



Pure white, pure jet, pure luxury . . . these are the marks of the world's fastest jetliners, Delta's new Convair 880's. Carrying 84 passengers in superlative comfort, the 880's will make their debut in May, augmenting Delta's fleet of magnificent Douglas DC-8 jets and increasing the number of cities served by Delta with pure jets from eight to eighteen in the United States and the Caribbean.

DELTA
AIR LINES

The air line with the BIG JETS



Tessitore of Alitalia, personnel department.

It took Air Union's economic department several months to work out an accounting system for the calculation of costs and earnings. Final draft was presented to the partners during the next discussions. The statutes of Air Union governing the new setup were submitted for approval and the basic principles of the partnership accepted. As far as Germany was concerned, it was agreed that from the start Air Union should take over the internal (cabotage) routes.

The members undertook to see that their individual governments regard Air Union as their national airline and that these governments do everything possible to promote its operations. In this way, parity in the utilization of international air traffic would be guaranteed.

These are the principles of the final Air Union agreement still being thrashed out in detail. But, as happened where the Common Market Treaty was concerned, several months will probably have to be allowed before it can be implemented.

Last Mar. 23, Dr. Heinz Rohm of Lufthansa outlined in a talk in Cologne certain changes in policy, based on latest operational figures of the four airlines involved, for which Lufthansa would have to press during the next talks.

For example, the quotas previously agreed to were: Air France 34%, Lufthansa 30%, Alitalia 26% and Sabena 10%, but it had now been found that this division was not yet applicable. Calculated on the actual performance of each airline in 1958, the figures work out at Air France 50%, Lufthansa 17%, Alitalia 15 %and Sabena 18%. Lufthansa considers this an indication that a longer interim period is required before they can be brought into closer relationship with each other when a more evenly divided quota will also have to be determined.

Dr. Rohm recommended that the final quotas be determined by linear variation until such time as total air traffic of all partners has reached 2,400-million ton/km. annually—about five times the 1958 figure. During that time it should be agreed that total value of each carrier's performance must not decrease, or if so, then only if the total value of Air Union's activities decreases also.

Excluding over-all cabotage agreements, all international traffic of the partners should be carried by Air Union, although certain exceptions to this general rule could be expected because of political and economic considerations.

Air Union's relations with the four governments concerned should be the subject of a separate government contract. This, together with the Air Union agreement, should form the basis of the partnership.

Air Union should, Dr. Rohm continued, distinguish two separate phases of operation: before the agreement becomes effective, representatives of all four airlines will form the organization's expert committees. After the agreement comes into force, these committees will gradually be converted into special administrative departments with particular emphasis on the traffic and sales side of management.

When applying first the temporary and then the final quotas, the difficulty arises of converting past performance into seats available which, for purposes of the individual accounting period, should be shared in advance among the partners. Operational expenses incurred should be deducted from each airline's earnings which all flow into Air Union to be distributed proportionately according to the allotted quotas. This way, each partner will try to increase his productivity to the utmost.

Chief aim of Air Union is to reduce over-all costs and thus increase the profit margin of each partner. A reduction in costs can be expected in the technical sphere chiefly because of the planned centralized supervision of the technical ground organization as well as the joint materials policy.

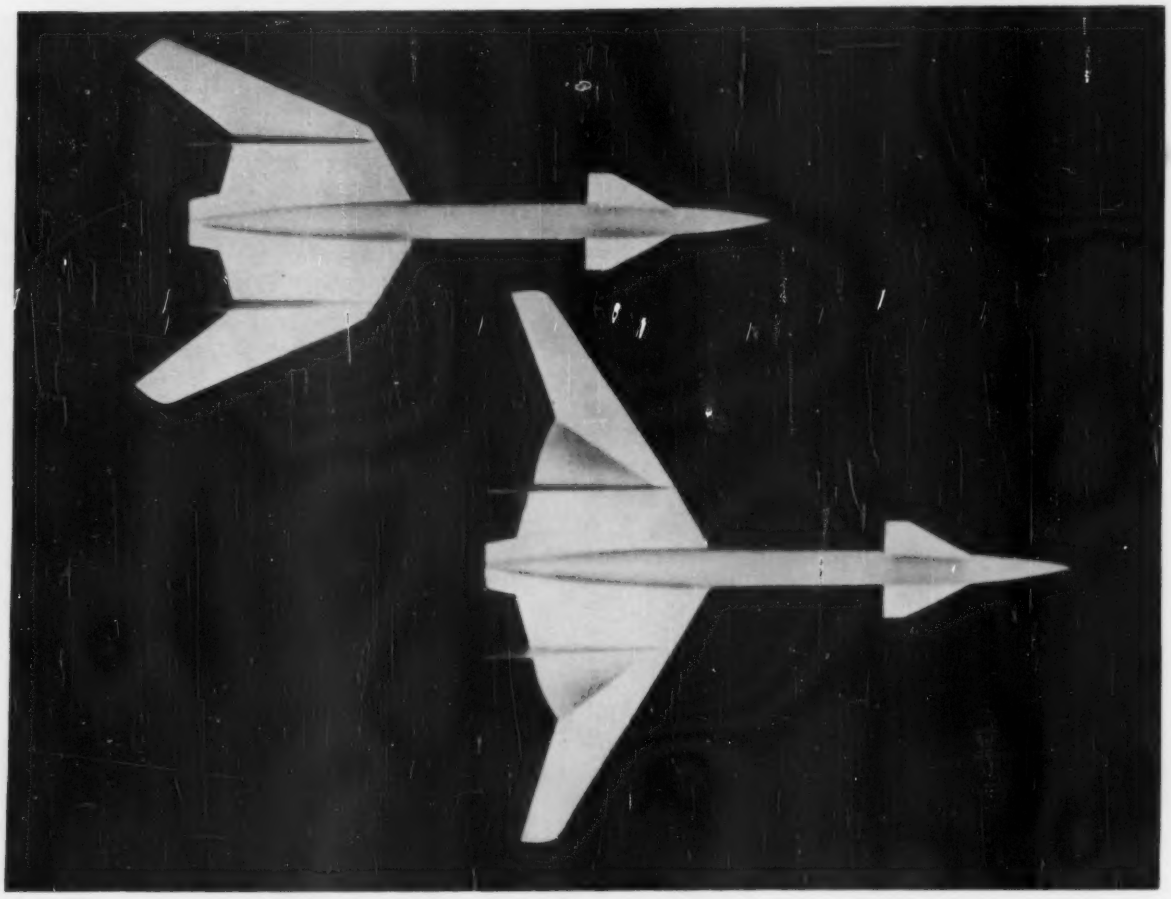
Economically, costs will be cut by the planned merging of the external organizations. Finally, it is expected that the formation of Air Union will enable the partners to share any risk or problem in balancing capacity as a result of the supersonic traffic.

The final meeting expected some time this month probably will reveal whether—or how far—Lufthansa can expect its partners to fall in with this change in policy.

Naturally, some of the other leading airlines in Europe outside Air Union which, for one reason or another, are unable to seek membership in the new organization, continue to watch it closely. According to some observers, Air Union may over the long haul force some airlines to get together in direct competition with Air Union. British European Airways probably will stay independent of any such partnership because it already dominates a group of "associated" companies having route systems in Europe and the Middle East.

United DC-8 Hangared at Denver

United Air Lines cut a hole in the door of this hangar, largest at Denver's Stapleton Field, to accommodate its Douglas DC-8 jet transports. The hole is 10 ft. in diameter; system retains most of the hangar heat, United maintenance officials said.



VARIABLE sweep wing on the supersonic transport model above is one of those under study at the Langley Research Laboratory of NASA. Langley engineers believe that variable wing geometry of this type is the best means of good subsonic, supersonic performance.

FAA, NASA Study Supersonic Transport

By J. S. Butz, Jr.

Washington—Three problems of critical importance have emerged from a coordinated Federal Aviation Agency-National Aeronautics and Space Administration program to identify and solve the basic problems of developing and operating a money-making supersonic commercial transport. They are:

• **Flight efficiency** of most proposed supersonic transport designs is high at their design cruise speed but low at subsonic speeds and in other off-design areas. Their off-design performance during takeoff, landing, climb, acceleration to cruise speed, descent and holding over the destination is below current requirements for safe and economical commercial operation, although it might be acceptable for military service.

• **Stainless steel construction** necessary for continuous cruise above Mach 2.3 at about 300F skin temperature, will not be ready for several years, particularly in view of the decreased development support by the Air Force with the stretchout in the North American Mach 3, B-70 bomber project. Construction costs also will be high. Adequacy of current aluminum structure for cruise near Mach 2 at around 200F has not been definitely established. No experimental data exists on the creep or fatigue life of aluminum structures soaked in these temperatures for several years at the airline usage rate of about 2,000 hr. per year, which is almost 10 times that of the military. Sandwich construction has a significant weight and performance advantage over skin-stringer structure, but it is much more expensive and its reliability is more open to question.

• **Engine performance required** will be above current capabilities if the gross weight of a 100-passenger-plus supersonic transport is to stay below 400,000 lb. and the number of engines limited to four to keep initial costs and maintenance expenditures down. Pure ramjets are not considered for the supersonic transport regardless of its operating Mach number. NASA, FAA and many manufacturers believe that a large turbofan with either afterburning or burning in the fan section will be able to meet the requirements of the supersonic transport to speeds between Mach 3 and 4. Primary impetus behind these vital engines is coming from commercial engine firms.

The two federal agencies believe they must take the lead in resolving these and other less critical problems revealed by their study before private financing of supersonic aircraft becomes feasible for the airlines and the airframe manufacturers.

None of these supersonic transport problems are considered insurmountable

by NASA or FAA officials, yet their solution will require a concentrated research effort as will a number of other design and operational questions. Present FAA-NASA effort in this area is not yet expensive, but the funding requirement will certainly grow and, with it, the need for program justification.

Dual Role

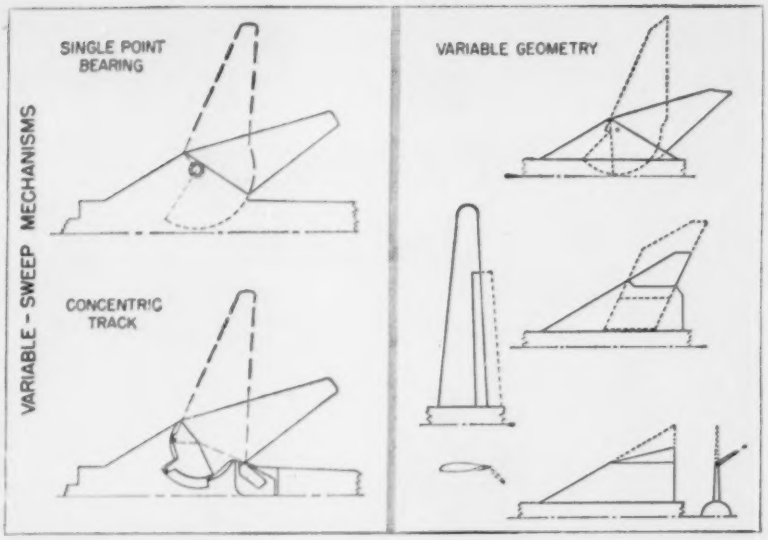
FAA Administrator Elwood Quesada, as well as many NASA and Department of Defense officials, believe the supersonic transport will play a dual role in the next 10 years—a major national prestige symbol and a commercial necessity. A Mach 2 transport, for instance, would cut a transatlantic crossing to less than half the present time. This aircraft could make three or more crossings a day and have the potential to make subsonic jets hopelessly obsolete economically for long-range flights. The nation which supplies such an advanced aircraft for commercial use certainly will be recognized for its achievement far beyond aviation circles.

Exact course the FAA, NASA, the military services and other sympathetic agencies will follow in pushing for the early development of a supersonic transport is not yet clear. The magnitude of the technical task has necessitated the type of preliminary program FAA and NASA are now pursuing.

Once this program has more clearly defined the problems and a logical development course, it will be possible to estimate just how much federal aid will be needed and how much of the job can be carried by private capital. Predictions as to the method of financing have ranged all the way from a complete commercial venture to a large federal appropriation for a specific aircraft project which would be conducted by an industrial firm under the direction of a civil agency of the government. The Air Force at present has no requirement for a supersonic transport.

FAA officials are now of the opinion that the government will have to support a sizable research and development program through their agency and NASA. This probably would include four or five experimental aircraft in order to build a large amount of flight time on a commercially attractive configuration within a relatively short time. The data obtained by the federal agencies would then be made available to airframe manufacturers in any effort they might make to sell supersonic transports to the airlines.

Last Nov. 13, technical officials from the FAA requested NASA's Langley Research Center to prepare a document summarizing the agency's technical background applicable to supersonic transports. Most of the NASA's work in this area had been done as an adjunct to research on supersonic bombardment aircraft.



TWO STRUCTURAL concepts that have been studied for the variable sweep wing are shown at left. The top one has a single vertical post to take the drag loads surrounded by a large bearing plate to take the lift. The other has a concentric track to take all of the outer wing loads. The investigation of this and other types of variable sweep mechanisms is still preliminary, but their weight penalty now appears slight. Four types of variable wing geometry considered by NASA are at the right.

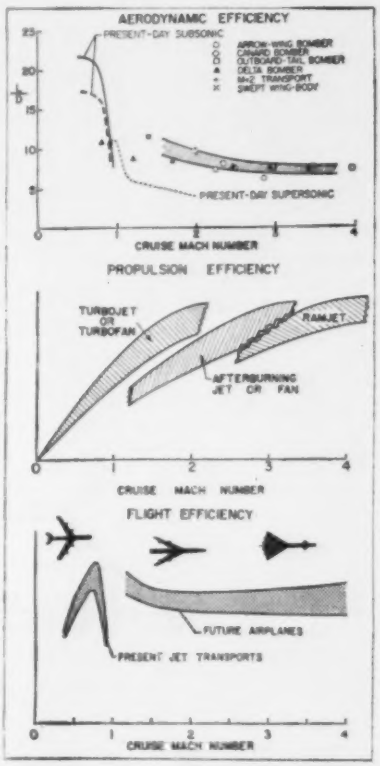
The summary report was prepared by 12 members of the Langley staff and presented verbally within 30 days to both FAA and NASA headquarters. This report essentially has established the goals for the detailed investigations now under way and those planned for the future. It outlines simply the design and operational problems known to be connected with the supersonic transport.

Research Programs

Two research programs generated by the report are now under way and a third—a flight test project with a Convair B-58—is scheduled to begin within the near future. If these efforts prove to be successful within their planned time period, the technical foundation for a supersonic transport should become much firmer within the next year.

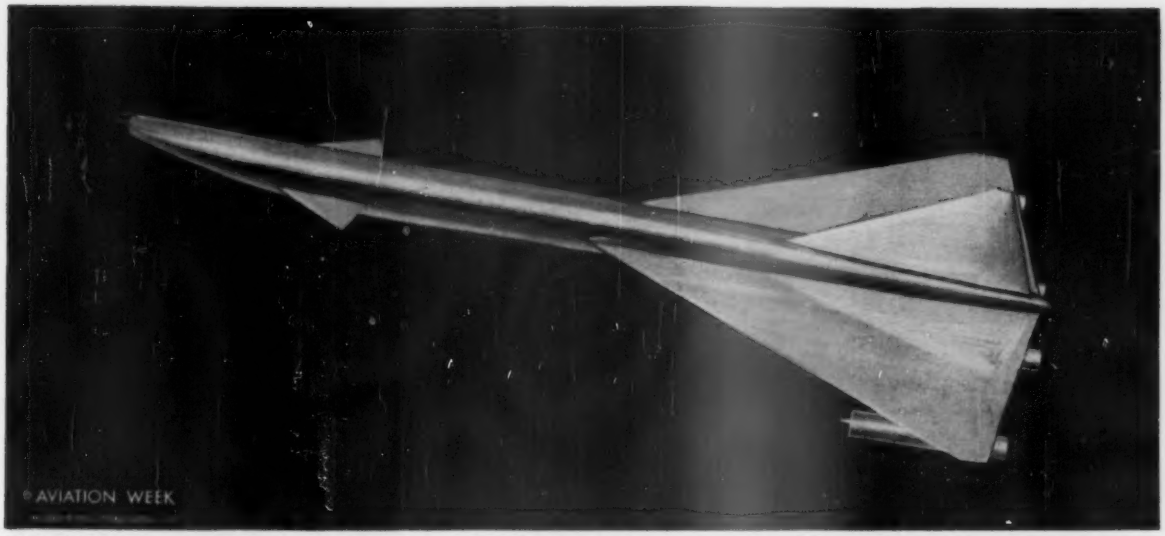
One of the current research programs deals with the soaking effect of high temperatures on several types of structure and materials. This is a long-term program since the soaking action cannot be accelerated the way normal fatigue tests can when the number of loading cycles in an aircraft's life can be applied within a few days. Since there are only about 9,000 hr. in a year, this is the maximum simulated flight time that can be achieved during a year of testing structural elements for creep and fatigue under high loads and temperatures.

It is expected that the current pro-



AERODYNAMIC EFFICIENCY of supersonic aircraft has been improved more than 50% in the last three years (top), but it is still small compared with that for subsonic designs. Difference in flight efficiency between subsonic and supersonic transports is predicted to be small however, (bottom) because propulsive efficiency is high (center).

Coming.... **the calm beauty of Japan** at almost the speed of sound



SUPERSONIC transport configuration receiving the most consideration in the recent past is a delta-canard type (above). Use of variable sweep wings may improve commercial attractiveness of this type of aircraft, according to NASA studies.

gram will produce a significant amount of data by next fall and permit a useful assessment of the high temperature qualities of aluminum structure at that time.

Second Research Program

The second research program in progress primarily involves wind tunnel tests to try and improve aerodynamic efficiency in off-design flight conditions. Basic data from these tests on the effects of aspect ratio, wing sweep angle, inlet location, type of control surfaces and other design variables are expected to point the way toward configurations with good flight efficiency at all speeds. NASA's research group at Langley now believes that the proper use of variable geometry will provide the solution to the off-design problem. The type of variable geometry that they favor is variable sweep angle on the wings (AW Mar. 28, p. 29).

Another primary objective of this wind tunnel program is to obtain a configuration that will cruise efficiently at Mach 2, 3 and 4 as well as land and take off at the same speeds as current subsonic jet transports. No current configuration proposed for a supersonic aircraft will cruise efficiently over a wide range of Mach numbers. If this problem can be overcome, it would be possible to build the first supersonic commerical transport of aluminum and cruise it at the maximum speed its structure will stand.

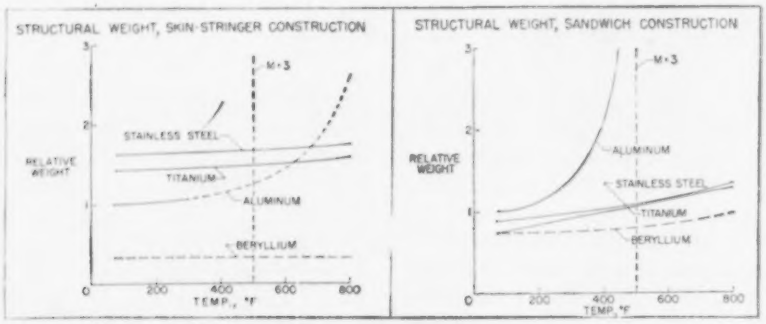
Higher Speeds

Then the same aircraft could be used at much higher speeds when steel or other advanced high temperature structures became available. Total development costs of any supersonic transport program would be greatly reduced if one configuration proved aerodynamically satisfactory throughout the supersonic Mach number regime.

The third research program scheduled to begin within the near future is a combined NASA-FAA-Air Force effort. NASA will operate a Convair B-58 on loan from the Air Force in a simulated transport operation. The FAA ground simulator facility at Atlantic City, N. J., will be the other element.

Initially, the FAA simulator will investigate operational procedures for the transport using the best input information available today. Since the operation of a supersonic transport will have to be held within close limits and a simulator program of this type is only as realistic as its input data, the B-58 will be used to check the computer results in flight and to provide more factual input information. The B-58 is considered a good aircraft for this study for three reasons—it has the excess thrust necessary to study the effects of power over a wide range of thrust-to-weight ratios; damping of its control system may be varied about all three axes so that control characteristics may be altered to some degree, and its wing loading range covers the area expected to be attractive for the supersonic transport.

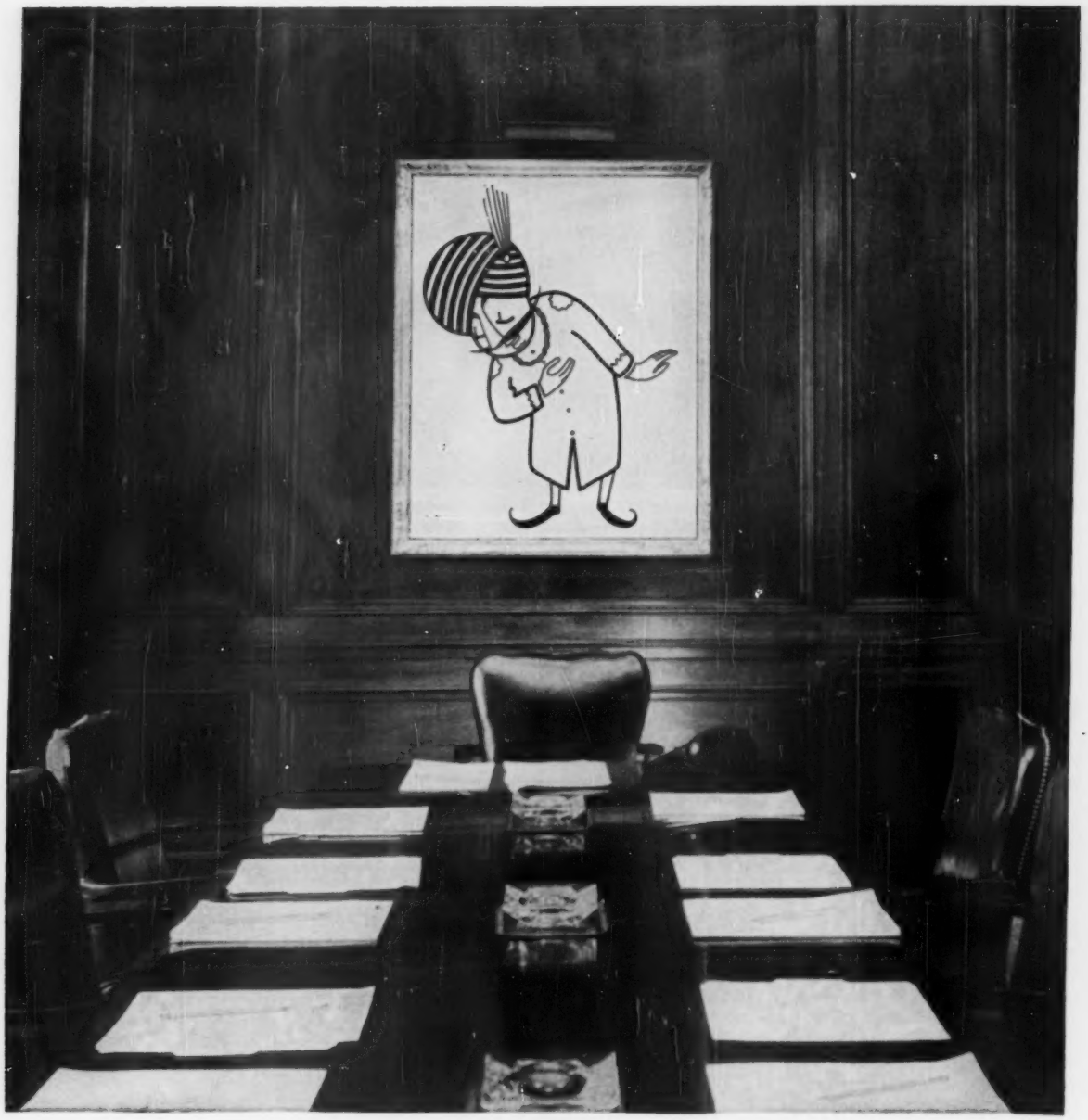
The lift-drag ratio of the B-58 is somewhat below that of the supersonic transport, and it is completely out of the gross weight class of the transport. However, these factors are not expected to effect the value of the supersonic flight program.



RELATIVE weights of skin-stringer (left) and sandwich structure (right) for several materials are shown above. Beryllium is included to provide a reference point. Depending upon the structural elements under consideration, sandwich can show a weight improvement of 50% or better over skin-stringer construction.

State-of-the-Art

The NASA summary report on the state of the aeronautical art as it applies to the supersonic transport is divided into seven parts, each dealing with a primary portion of the problem of building and operating these aircraft. It is clear from the Langley report that a concentrated effort of considerable cost and length will be required before the



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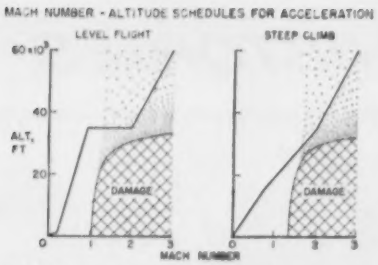


FLIGHT procedures for supersonic transports will have to be closely regulated to prevent ground annoyance and damage. Level flight procedure (left) and steep climb (right) are shown above.

supersonic transport is operating at a profit.

A relatively-large effort has been made to increase the aerodynamic efficiency or lift-drag ratio of supersonic aircraft and the effort has paid off with an improvement of from 50% to 75% in the last three years. However, best supersonic lift/drag ratio is still only about one-third that of current subsonic jet transports.

It appears that the total flight efficiency of the supersonic transport will be only slightly below that of subsonic jets because the propulsive efficiency of jet engines increases rapidly at supersonic speeds. NASA engineers believe more improvement can be made in supersonic lift/drag ratio and that further research in this area is needed to obtain maximum performance.

Two major requirements are cited if supersonic flight efficiencies on full-scale aircraft are to equal those obtained in model tests. The first is a very smooth surface with no sand-grain-type roughness or offsets between adjacent structural panels thicker than three sheets of tablet paper. This applies over the entire surface of the transport area, probably about one-third of an acre.

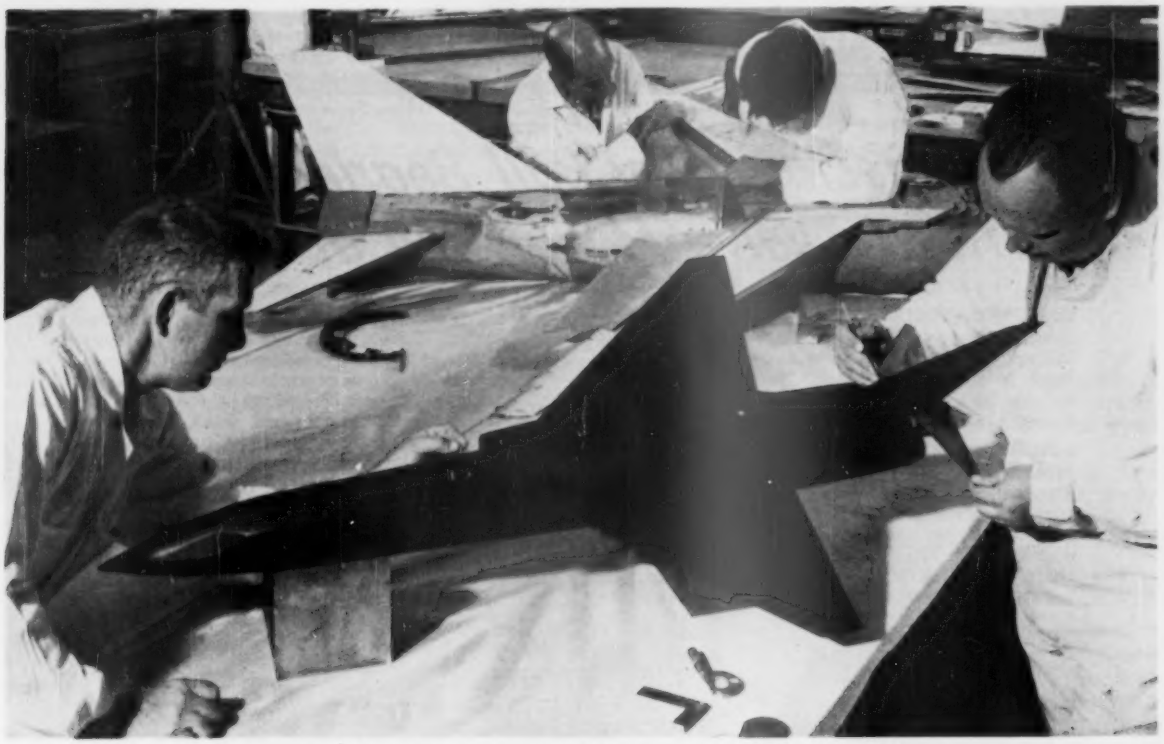
Slender Fuselage

The second requirement is for the over-all configuration to be very slender. The fuselage diameter will be so small relative to its length that the seating arrangement on a 100-passenger transport will have to be as compact as present coach seating. The short flight times of the aircraft are expected to keep this situation from being objectionable.

It was concluded that the present state of the art was sufficiently advanced to permit the design of an aircraft at least marginally capable of performing the supersonic transport mission. However, these designs also were considered to have unsatisfactory off-design performance and to have insufficient operational flexibility.

Four types of variable wing geometry were mentioned by NASA as possible means of improving off-design performance. The first is the conventional wing flap best suited to long, slender wings of high aspect ratio. Since the supersonic transport will have low aspect ratio wings, it is considered more favorable to apply variable geometry at the wing tip than along the trailing edge. Fold-down wing tips similar to those used in the design of some bombardment aircraft, and a telescoping wing section at the tip have been suggested in this area. The type of variable geometry considered most seriously by NASA has been the variable sweep wing. The basic stability problems connected with a large shift in the center of wing lift are believed to have been solved.

The variable sweep wing in NASA's estimate provides the high aspect ratio needed for the 400,000 lb. supersonic transport to take off in less than 10,000 ft., land at touchdown speeds of about 120 kt., climb efficiently to at least 35,000 ft. at subsonic speeds and to hold efficiently over a landing field at subsonic speed. In its swept configuration, this wing also will match the supersonic efficiency of the fixed wing delta-canard configuration under study by many designers. This aircraft's configuration has a large fixed delta wing at the rear of the fuselage with a canard



Boeing's Wind Tunnel Team Builds Models

Members of Boeing Aircraft's wind tunnel team construct advanced design models at Boeing's Wichita, Kan., model shop. Models are used mainly for tunnel tests, although the team has built 1/10th scale models for free flight telemetered supersonic drop tests.

CASE HISTORIES

Special high-temperature, full complement N/D ball bearing, made of cobalt base alloy, operates successfully at high temperature with no need for lubricant protection!

Photo: Courtesy Stratos Division, Fairchild Engine and Airplane Corp.

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C-130 Tests Boundary Layer Control System

Lockheed C-130 testbed for boundary layer control system (AW Feb. 15, p. 35) makes approaches to stalls using flap settings of 30, 40 and 60 deg. at Marietta, Ga. Testbed's two additional turbojets drive compressors to blow air over control surfaces. Engine power is at idle during tests, and power setting at 75%. Stall speeds can be reduced to 60 mph., compared with 90 mph. for C-130B freighter.

control and stabilizing surface forward near the nose.

Landing speeds of the fixed delta-canard configuration are 20 kt. or more above the 120-kt. figure believed to be a maximum for commercial operation safety by many operators and airframe manufacturers. Takeoff distances for the fixed delta-canard aircraft also are well above 10,000 ft. if the aircraft thrust-to-weight ratio is only around 0.3, which is regarded as the optimum for economical commercial operations by many engineers.

Improved takeoff performance for the variable sweep wing comes primarily from the fact that, when it is in the straight configuration, it generates much more lift per degree of angle of attack than a delta wing with a swept leading edge.

Since it is considered impractical from the standpoint of landing gear design and passenger comfort to take off at more than 15 deg. angle of attack, the variable sweep aircraft generates much more lift that the delta-canard type and will takeoff in a shorter distance.

Engine-Airframe Matching

Takeoff runway requirements for the supersonic transport will depend largely upon the powerplant arrangement. FAA regulations call for a transport aircraft to be capable of completing a takeoff with one engine out after it reaches a point on the runway beyond which its brake system will not stop it without a runover.

This regulation is not expected to be relaxed.

Aircraft with six or eight engines will need less runway than those with four engines because they can meet this engine-out requirement more easily.

The ideal arrangement sought by NASA and many airframe and engine manufacturers is to have four turbofan engines that can get the 100-passenger aircraft off in less than 10,000 ft. without afterburning or burning in the fan section. Then, if one of the engines stops, auxiliary burning can be started immediately in the other three, and the takeoff thrust still could be maintained.

Two Requirements

Two requirements that may materialize are strengthening and smoothing of existing runways and taxiways at international airports. Since range of gross weights considered possible for the supersonic transport is 350,000 to 600,000 lb., reinforcement of runways and taxi strips is likely. It is not yet known just how the delta-canard configuration, with its widely separated nose and main landing gear, will respond in pitching and normal accelerations to the roughness of existing runways and taxiways.

In general, the turbofan engines which apparently hold great promise for supersonic transport application will use maximum auxiliary burning during acceleration to cruise speed. It may prove possible to eliminate afterburning altogether and still obtain adequate transonic acceleration power with burning in the fan section.

If burning in the fan section alone proves adequate from a thrust standpoint, it is theoretically possible to make a large reduction in engine specific fuel consumption during cruise and transonic acceleration. Use of fuel in the fan section is much more efficient than in an afterburner and almost as efficient as in the normal engine cycle.

The NASA report lists fatigue as perhaps the major structural problem existing today. The problem is expected to be compounded by increasing flight speeds into the supersonic regime because of the temperature rise. Comparatively little information is available on metal fatigue at elevated temperatures and practically no data is available on the fatigue of structural components. So far as NASA can determine, none of the numerous studies of the explosive failure of pressurized fuselages at subsonic speeds have been extended into the temperature range of interest to the supersonic transport.

Creep is not expected to be a major problem on supersonic transports made of either stainless steel or titanium. NASA studies have shown that creep may not occur at the stresses to which the transport structure will be subjected at elevated temperatures.

Creep of aluminum structures is under study.

Weight Advantage

The weight advantage of sandwich structure over skin-stringer construction is so high that considerable effort will be expended to fully develop it. The structural savings run as high as 50% on some structural elements, in current estimates.

Open face sandwich, in which the core is backed by a flat plate on only one side, is being studied to relieve the inspection problem.

Relative costs probably will be a controlling factor in the selection of materials and construction methods. Conventional aluminum skin-stringer construction costs approximately $25 per lb. of structure. Brazed honeycomb sandwich construction can run as high as $200 per lb. of structure.

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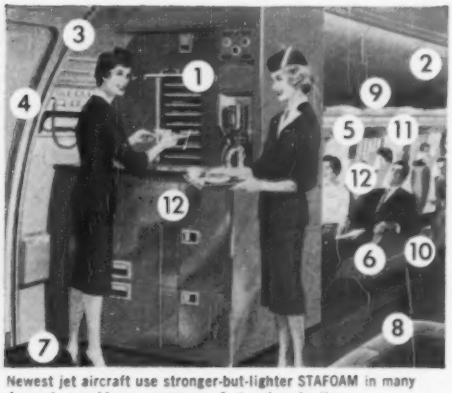

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Blackburn NA.39 Makes Catapult Test

Blackburn NA.39 low level attack aircraft for British Navy undergoes catapult trials on HMS Victorious, Royal Navy carrier. Powerplants are two de Havilland Gyron Jr. turbojets.

ent upon the accuracy of the design loads, and in this area there are still many uncertainties regarding the supersonic transport. The aircraft will fly between two and three times the altitude, Mach number and dynamic pressures of the subsonic jet. These design points have yet to be established.

The hot structure, plus the fact that the aircraft will have most of their weight concentrated in the fuselage with little of it distributed along the wings, will affect the load distribution.

Main problem areas which will have to be studied are gusts, maneuver loads, ground loads, flutter and buffet. The turbulence environment existing between 50,000 and 100,000 ft. is largely unknown, particularly turbulence in the jet stream and the effect of the mountain wave phenomenon. It will be impossible to slow the supersonic transport effectively at cruise speeds to reduce gust loads. At low altitudes and subsonic speeds, any operation at reduced speeds to cross large turbulent areas will be economically unfeasible because of high fuel consumption. Variable geometry would allow the supersonic transport to operate as present subsonic transports do in this area.

Maneuver Loads

Maneuver loads on the aircraft during operational and check flights will continue to be a major part of the total loads experienced. NASA studies to date indicate that they will not differ materially from the maneuver loads on subsonic jets. Ground loads will be somewhat higher than on current jet transports because of the new landing gear configuration and increased gross weight. If sink or touchdown speeds are allowed to exceed those of the present jets, ground loads will increase rapidly.

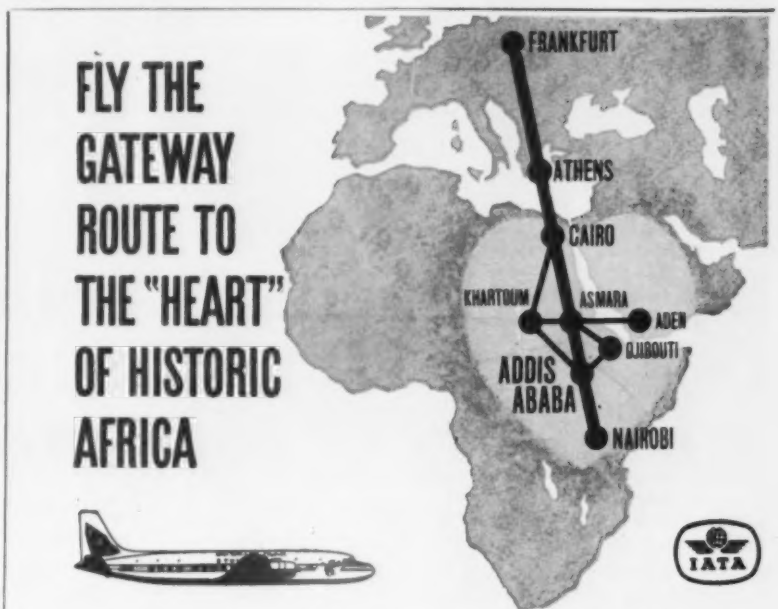
Flutter and buffet loads are expected to be similar to those now experienced.

There will be three main noise sources on the supersonic transport—engine, aerodynamic boundary layer and shock waves—and, in general, the noise problem will be much more severe than on a subsonic jet. Pure jet engines are expected to require ground and in-flight muffling. The mufflers would have to accommodate higher temperature exhaust gases than those of current powerplants.

Because of the probable development potential of the turbofan engine, however, the engine noise problem may eventually be reduced for three reasons. They are: total noise power will be reduced through greater jet efficiency, noise spectrum will be shifted to lower frequencies and the aircraft may be capable of steeper climbs to avoid populated neighborhoods.

Several thousand pounds of soundproofing material are required aboard subsonic jet transports, and the weight of this material may have to be substantially increased on the supersonic transport. The currently estimated structural weight of the supersonic transport also may have to be increased to resist sonic fatigue. Both of these considerations are required primarily by the great increase in boundary layer noise at supersonic speeds.

NASA research in the past has shown



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that the only practical solution to the wave-drag, sonic-boom problem lies in the control of aircraft operation. Only small reductions in sonic boom intensities can be affected through judicious shaping of aircraft's external configuration for any given weight.

Magnitude of the booms on the ground can be controlled by regulating an aircraft's speed-altitude relationship or its speed-attitude relationship. If a transport's climbout is made at subsonic speeds to an altitude of about 35,000 ft. before acceleration to cruise speed is begun, shock wave damage on the ground can be eliminated and annoyance kept low.

The sound experienced on the ground directly below a heavy supersonic transport which is accelerating through Mach 1 at 35,000 ft. will be similar to a heavy freight train passing at high speed about two blocks away. The variable sweep wing will greatly improve flight efficiency during the subsonic climb.

An alternate procedure, if a high thrust-to-weight ratio is available, is to accelerate while climbing at supersonic speeds. This climb must be steep with the nose rotated to a high angle so that the trailing shock system is also rotated away from the ground. A rotation of about 20 deg. will give an effective reduction in ground pressure of about 0.3 Mach number. This procedure is believed to be marginal because it is greatly effected by wind changes.

Two other operational recommendations have been made by NASA to reduce the ground noise problem. Deceleration should be made at the highest possible altitude, and maneuvers at supersonic speeds should be avoided to prevent concentrating the strongest pressure waves from the aircraft at a given point on the ground.

Economical Operation

Economical operation of the supersonic transport will require that extremely precise flight patterns be flown, and current plans are to give the highest priority to these aircraft in the air traffic control system with all takeoff, airspace and landing pattern reservations made before the engines are started. Reserve fuel requirements will affect the design of this transport more than others in the past. Studies are now being made to determine if the projected improvements in the air traffic control system would allow some reduction in fuel reserves.

On the average 3,500-mi. mission, the supersonic transport with fixed delta-canard configuration would cover about 300 ground miles climbing out and accelerating to cruise speed. If an optimum altitude cruise, rather than a constant altitude cruise, is not allowed by the air traffic control so that the aircraft can gain altitude constantly as it burns off fuel, an additional ton or so of fuel would be required.

This penalty would eliminate approximately 10 passengers, if taken out of the payload. Holding over the destination rather than scheduling a straight-in landing would impose a more severe penalty.

A 30-min. hold at Mach 0.8 at 35,000 ft. could require an additional 10 tons of fuel, which would effectively climinate two-thirds of the passengers. If the same hold was necessary at Mach 0.4 at 5,000 ft., there would be an 11 ton fuel penalty.

No visual flight rules will be followed during supersonic transport flights because of the precise navigation requirements, which must be aided by ground equipment and the inability of the pilots to effect visual avoidance of other traffic.

Under present planning, the flying qualities of the supersonic transport must be essentially the same or improved over those for current high speed transports.

The problem of achieving these flying qualities with supersonic transport configurations is elaborate, and it will require the use of automatic damping systems around all three axes. In general, the dynamic lateral stability of supersonic transport configurations is reduced below that of present subsonic jets for two reasons.

First, the weight has been moved out of the wings into a long narrow fuselage, and the damping action of the light low aspect ratio wings is very low.

Second, the transport will fly at higher altitudes than customary, which further reduces the damping of the lifting surfaces. Damping of directional or yawing motion is reduced to almost zero at high altitudes without enormous stabilizing surfaces.

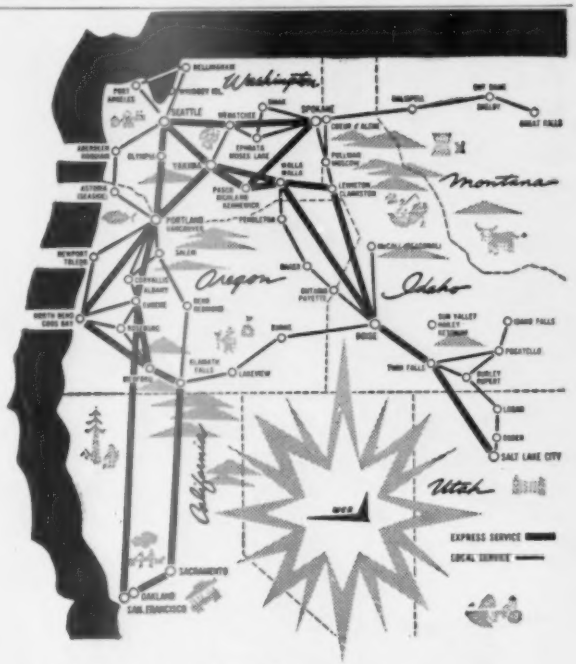
Automatic Damper

On current high-speed configurations, it is virtually impossible for the pilot to control the aircraft if the automatic yaw damping system stops operating.

Dynamic stability problems of this type and others regarding static stability will require an entirely new approach to the certification of commercial aircraft which depend upon avionic systems for their safety.

The variable geometry wings are believed by NASA to offer the best research possibility of improving the inherent static and dynamic stability of supersonic transports in all speed ranges.

Any improvement in the inherent stability of the aircraft will lessen the dependence which must be placed upon avionic systems and may reduce the weight which must be allotted to them.



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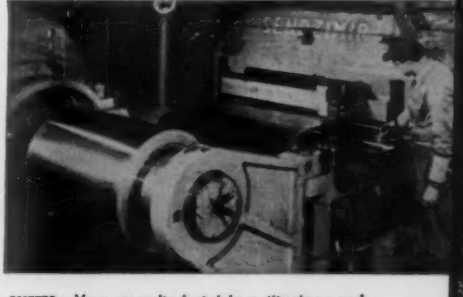

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DELTA AIR LINES' first Convair 880 jet transport was the first production 880 to fly. Crew training began in mid-February, Delta will begin

Delta 880 Training Paves Way for May

By Richard Sweeney

Atlanta—Delta Air Lines, scheduled to begin Convair 880 jet transport service on May 15, anticipates a relatively trouble-free transition to the new aircraft in scheduled operations.

The expectation is based largely upon experience gained thus far with the one 880 which Delta has had since Feb. 12 for crew training work. The transport, operating under a provisional certificate, began the training schedule in mid-February and had logged more than 330 hr. by mid-April.

During this time, not one flight had been aborted due to airframe or powerplant problems.

Delta groups that have worked with the aircraft since its delivery flight—on which it set a new transcontinental speed record for transports by averaging 665 mph. between San Diego and Miami—indicate that they feel this way about it:

- **Engineering department personnel,** who will make up the schedules based on the 880's actual performance, and those in charge of the airframe, engine and systems say they are finding their expectations met or exceeded.
- **Maintenance men,** who have kept the airplane flying during the training period, report favorably on the comparative ease of maintenance. Some have worked on military aircraft as well as other jet transports.
- **Pilot training personnel** are pleased with the 880, its handling qualities, flight characteristics, performance and availability rate.

This AVIATION WEEK pilot got an indication of the airplane's flying qualities when he flew it from Augusta, Ga., to Atlanta, landed it at Atlanta.

The flight was a training mission in which Delta Atlanta chief pilot Ted Johnson, was flying a routine syllabus, including engine-out takeoffs, two-engine-out approaches and landings, holding patterns and ILS approaches. The instructor was Delta chief pilot T. P. Ball.

Service Schedule

Delta will begin service on its Houston-New York, New Orleans-New York and Atlanta-New York runs with three aircraft. Delivery of one aircraft was slated for Apr. 29, another for Apr. 30. The airplane being used in crew training, N1901, was to return to San Diego on Apr. 20 for rework so that it would comply with all the final Approved Type Certificate provisions and have its interior polished for the beginning of passenger service. It is scheduled to be returned to Delta on May 11.

As of mid-April, it appeared that the 880 would get its certificate on schedule on May 1, meeting or exceeding all performance guarantees. At that time, almost all flight testing had been completed, including the 150 hr. simulated airline operation which makes up the functional and reliability program. FAA data reduction was nearing completion.

Initially, the airline plans a utilization rate of about 8 hr. per day for each 880 on the three planned runs, which are Delta's longest nonstop domestic stage lengths. As more aircraft are delivered and, if performance in service is as good as expected, a number of cities on Delta's routes may get turbojet service which have done without it thus far because of runway or other limitations.

Delta engineering officials say that thus far 880 systems, such as hydraulic and electrical, are working better than anticipated. Usually, they approach any new aircraft with a "wait-and-see" attitude toward such systems. Even greater caution surrounded the 880, since it uses equipment which is new in concept and/or is made by manufacturers who are new to the commercial airline field, although they have been building military systems for a number of years.

Problems which usually develop in the systems of a new aircraft have either been much less severe than expected or nonexistent during the 880 flight hours logged in training. The hydraulic sys-

880 service on May 15.

15 Service

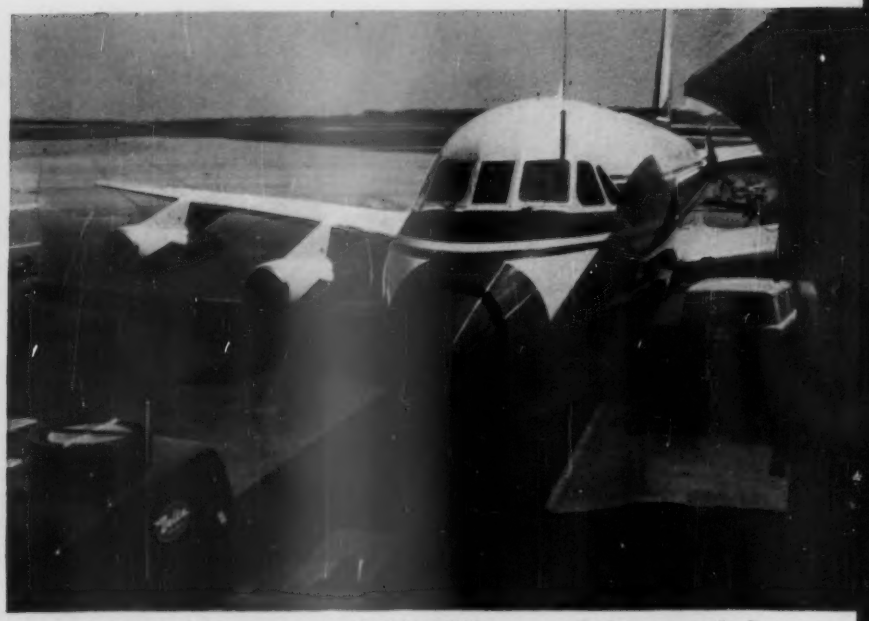
tem, as an illustration, uses a new pump design concept that might have been a headache but up to now has been trouble-free.

One new system concept on the 880, which appears to be paying off in less airplane down time, according to Delta, is the use of single-unit freon packs. Two mechanics can change a pack in one-half hour when an air conditioning fault appears. Then, check-out and component replacement can be done in the shop. The unusual practice has been to use a group of components installed individually in the airplane, which work together as a system, but must be checked out one at a time to accurately isolate a fault.

Hydraulic Actuation

Another innovation on the 880 is hydraulic actuation for thrust reverser clamshell doors, which was developed by General Electric as part of the CJ805-3 powerplant package contract—Boeing 707 and Douglas DC-8 use pneumatic clamshell reverser door actuation. General Electric also is supplying the constant speed drives and alternators for the electrical system, enabling a high degree of integration to be accomplished in the engine package.

Each powerplant package, for example, has one engine-mounted tank which carries all the oil needed for



DELTA AIR LINES' crew-training CV-880 N1901 is seen at the jet passenger loading ramp at Atlanta. Delta expects 15-17 crews checked out when 880 service starts in May.

DELTA HAD COMPLETED almost all flight testing, including the simulated 150-hr. airline operation which makes up the functional and reliability program, as of mid-April.

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engine lubrication, thrust reverser actuation and constant speed drive fluid. Each tank has two compartments, one for lubrication oil, the other for reverser and constant speed drive fluid. Should constant speed drive fail and its fluid be lost, a standpipe in that compartment saves enough fluid for reverser actuation. Although using a common fluid source with the constant speed drive, the thrust reverser has its own hydraulic system components, such as pump, check and relief valves, filter.

The Delta instructor pilots who checked out crews on the DC-8 are also conducting 880 flight training. Their opinion of the 880 coincides with that of other Delta people. Delta chief pilot Ball says "it's like flying a fighter with 84 people looking over your shoulder."

Delta plans to have 15 to 17 flight crews checked out when 880 service starts, with a goal of 37 crews by October, when initial checkouts will be completed. Training after this will be for replacements only. As of Apr. 9, four supervisor pilots and seven line captains had completed transition and obtained their FAA type rating.

All line captains checked out as of that date had had no previous swept wing or jet experience and transitioned into the 880 straight from propeller-driven transports. Their opinions varied individually, since they were new to jet transports, but the over-all impression was to take the aircraft seriously and treat it respectfully, although there was no fear of it. Some of these early crewmen had received training in the procedures' trainer during ground school at Convair-San Diego, but this was the closest contact they had with the airplane before they actually had to fly it.

Original Delta planning was for about 12 hr. flight training for captains prior to the FAA-type rating check, without benefit of the Link flight simulator, which Delta has purchased and is now being installed at Atlanta. Experience thus far, however, has been that a total of from 18 to 20 hr. is required in checkouts, including the 2½ to 3 hr. FAA-type rating check.

Delta opinion is that the pilots have done well in transition, especially since they had had no turbine experience and/or simulator time. In jet training, Delta is applying closer tolerances on routine flight maneuvers, takeoffs and landings, especially in airspeeds, than those used with propeller-driven airplanes.

However, demands are made only within the limits of airspeed and altimeter gage capabilities.

Delta has only pilots on the flight deck—there are no mechanic-flight engineers. Since 1948, Delta has employed only pilots (more than 500 of the current total of 720 on the pilot roster), who have received flight engineer training and obtained FAA flight engineer certificates. Under the single-union contract, Delta flight crewmen are designated captains, first and second officers. The first and second officers have the choice of bidding either as copilots or flight engineers. In the new jet programs, however, when copilots and flight engineers bid and are chosen for 880 training, they agree to stay with the aircraft in that capacity for a specified number of months to protect the line from training a man for the new plane, only to lose him to other equipment or have him bid for a different cockpit position.

Under FAA rules now in effect or forthcoming, several changes had to be made in flight crew training. Beginning Jan. 1, 1961, all copilots will have to be trained on the equipment they fly, and a recurrent annual check passed. Maneuvers to be performed are spelled out and are almost identical to those given a captain. However, less stringent tolerances are applied. This training must be completed by Jan. 1, or first officers cannot function in that capacity. Delta plans to start this training in the 880 this month so that all the first officers required will be trained

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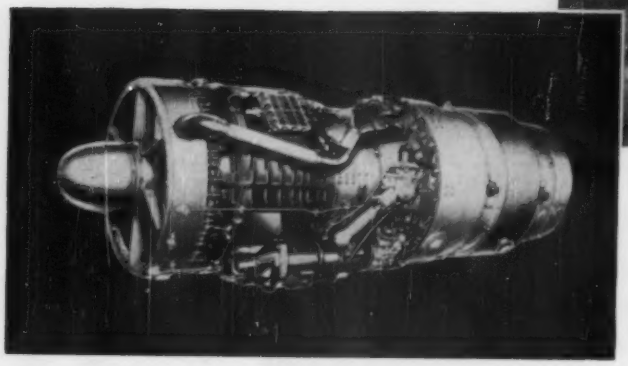

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and checked by the deadline.

FAA also has instituted new procedures for systems operators—flight engineers and second officers. Formerly, these crewmen were not type rated on each airplane. For the jet transports, however, second officers are given an oral exam on the aircraft and their work observed in flight by FAA, after which, if all conditions are successfully fulfilled, the agency sends a letter to the airline stating that the individual is considered competent to perform these duties aboard this type aircraft. The procedure, begun with DC-8s, is continuing in 880s.

To train second officers, Delta picked a number of men off the line who showed good promise as instructor personnel. These men are being trained, after which they will be observed by FAA. The agency is then expected to write letters on each man to the airline authorizing them to perform the training function and designating them as "check airmen" for this work. These men will, in turn, train the line-crew second officers in the systems' operator functions.

Jet crew checkout begins with three weeks of ground school, which will include 20 hr. simulator time for all crew members when the device is operating, according to present planning.

Actual flight training is carried on under a program which Delta developed and which FAA has approved. This consists of eight flight periods, with the work accomplished on each spelled out. The syllabus is in the form of a worksheet for each captain, and, as each step is completed, it is noted on the training worksheet-log. Programs are built around captain checkout.

On each flight, two trainee-crews are aboard. Each trainee-captain gets at least two full hours of stick time on each flight, which lasts a minimum of 4 hr. For the third and fourth periods, the captains are on the ground taking FAA oral exams, and during these sessions each copilot gets 2 hr. stick time, for a total of 4 hr. During the flight periods, while one position trainee is working, the other observes, adding to over-all flight time utilization.

With two flight periods per day, a captain can be checked out every sixth day. With two crews aboard each flight and eight flights in the course, each captain gets a minimum of 12 hr. stick time, 4 hr. systems operator panel time and 8 hr. observer time. Each first officer gets 4 hr. stick time, 2 hr. at the systems' operator panel and 10 hr. observer time.

Each second officer gets 6 hr. panel time, 10 hr. observer time.

The way the flight schedules have been established, each captain, as well as other crew members, obtains his training with at least two different instructors, sometimes three. Although the one-instructor vs. multiple-instructor system is debated in many quarters, Delta feels the latter has a number of important advantages. Among them: What one instructor doesn't cover, another will.

From experience with the 880 thus far, Delta chief pilot Ball indicates that he feels that training standards should be established to fit the specific airplane involved rather than on an industry-wide generalization as to the types of aircraft. With the performance and reliability of the 880, Ball says the real limit on training has been on a lack of instructors rather than the need for an airplane, demonstrating the 880's high capabilities.

Delta uses a minimum of expensive mockups and systems' trainers in its technical programs. One reason the airline purchased a $1 million Link flight simulator rather than a procedures trainer at one quarter the cost is a hope that the Federal Aviation Agency will follow through on its indication some time ago that six-month proficiency checks will be permitted in simulators, providing a considerable savings in flight time and cost. Three maneuvers, which probably would have to be performed in an airplane, would be engine-out

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North Central continues its leadership in the local airline industry, with 1959 marking our greatest year of growth.

1st in Passengers: for the fourth consecutive year, with a record 957,751 revenue passengers carried in 1959.

1st in Air Mail and Express: North Central again leads the local airlines in mail volume. In June, 1959, North Central began air freight operations. By the end of 1959, 14,000,000 pounds of cargo were carried, including freight, air mail, express and expedited surface mail.

Progressive and Continuing Route Development: route system expanded to 5,366 miles, serving 70 key cities in a nine-state area. In March, 1959, service was extended to the western chain of key cities — Minot, Devil's Lake and Bismarck-Mandan, North Dakota; Aberdeen, Huron, Mitchell, Rapid City, Pierre and Spearfish, South Dakota; Mankato and Worthington, Minnesota. Appleton and Ashland, Wisconsin, were added in July; and Fairmont, Minnesota, in December, 1959.

New service to Benton Harbor/St. Joseph, Michigan, from Grand Rapids and Chicago became effective January 1, 1960.

Equipment: April, 1959, marked the inauguration of service with Convair Super Northliners, radar-equipped, pressurized cabins, 44-passenger capacity. The fleet now includes 37 aircraft — five Convair 340's and 32 Douglas DC-3's.

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takeoff, two-engine-out ILS approach and a crosswind landing.

An additional use for the simulator will be to provide for those ground handling and maintenance personnel who would benefit from checkouts in their respective areas. Persons who will taxi the aircraft, for example, will receive simulator training on engine starts, power management and operation of required systems. Delta feels this should help eliminate such things as hot starts on engines.

Most of Delta's technical training is based on classroom work with charts, slides and transparencies for training on new equipment as well as upgrading personnel or retraining them.

In training aids, Convair furnishes three sets specified by contract. With the large use it makes of transparencies and similar aids, Delta makes more as it needs them, either quantitatively or in areas where they are not furnished.

It is expected that some 160,000 to 170,000 technical training manhours will be used in introducing the 880, while additional time will be spent when the transport begins service to new bases and/or new personnel are added to the program.

Delta started its 880 technical training project by sending a group of instructors and maintenance personnel to Convair-San Diego for initial training.

W. L. McBRIDE (left), base chief pilot at Miami, and James H. Longino, assistant base chief pilot, Atlanta, occupy cockpit of Delta's first 880. Standing is T. P. Ball, Delta superintendent of flight operations. Ball and Longino are handling 880 checkouts.

These people then returned to Atlanta and established Delta's program patterned upon the one used at Convair. After this, a group of Convair personnel visited Delta, taught a class on the airplane and helped the airline get its program well established.

The first three flight crew classes attended 880 ground school at Convair-San Diego, with two classes receiving

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Curtiss-Wright VTOL Makes Maiden Flight

Curtiss-Wright vertical takeoff and land test aircraft has made its maiden flight, climbing to 5,000 ft. and flying at 165 mph. Plane is shown with nacelles tilted for VTOL flight. The VTOL utilizes Curtiss-Wright's new radial lift propellers (AW Apr. 18, p. 73) driven by a single turboshaft engine. Company is building a six-place executive version which will use four propellers (AW Apr. 25, p. 30). Plane will have a 400-mph. cruise speed.

instruction in the factory procedures' trainer. The third crew, which did not get this work at Convair, will be the first through the Delta simulator at Atlanta.

A new addition to Delta's pilot ground school curriculum is high altitude indoctrination. One phase covers physiology, including hypoxia and other pertinent subjects. Trainees do not make a low pressure chamber run or experience rapid or explosive decompression, although a film on these is shown.

Second phase deals with high altitude meteorology and its importance to jet operations.

Stewardesses receive training in emergency procedures and other aspects of their duties in connection with the 880, on the airplane.

Dispatchers or flight controllers for the 880 also receive training—about 40 hr. of aircraft familiarization and high altitude meteorology.

When the 880 goes into full service, it is anticipated that line maintenance will be done at Miami and Dallas, while overhaul is done at Atlanta.

For line maintenance personnel, approximately four weeks of training is given in airframe, powerplant, hydraulic, electrical and pneumatic systems in the form of an over-all aircraft familiarization program.

For Atlanta overhaul base specialists, two weeks of training will be given, usually at the factories of the vendors. Powerplant specialists will receive five days' of training on the CJ805-3. A 40-hr. familiarization course will be given radio mechanics on 880 equipment.

Key Delta personnel, including maintenance instructors and inspectors, were sent to the Convair factory for a six-week course on the 880, after which they spent several weeks more in on-the-job training at the factory. The same general areas were covered as in the four-week course for day-to-day crews who will work with the transport. Delta inspectors were at the factory while the initial 880s were being fabricated, then returned to Atlanta to become the nucleus for 880 inspection teams.

Other essential people—including ramp personnel such as shift supervisors or relief supervisor mechanics—are brought to Atlanta from stations which will have 880 service early during the pilot training program for actual maintenance work on the training aircraft so that they will be familiar with the aircraft when service to their stations begins. This experience is to top off their classroom and other theoretical training work.

A separate course is given for persons who will work with ground support equipment for the 880—such units as the air turbine truck, the diesel-engine electrical ground power vehicle and other specialized systems.

All Delta personnel who receive technical training also take written examinations on the subjects, which are closely graded. Anyone failing to meet the required standards usually winds up retaking the course on their own time until they meet specification.

Delta first began 880 training about three years ago when the aircraft was ordered, with General Electric presenting a five-day course to approximately 1,000 persons on jet engine principles.

Along with technical training, Delta also is conducting nontechnical training for the 880. This provides all the information necessary for handling the aircraft on the ramp from the time it arrives until it leaves. Work covers such activities as refueling, cargo and baggage handling, moving the plane with a tug, cabin servicing and food loading.

All shift and ramp supervisors at stations scheduled to receive 880 service are brought to Atlanta for one day on-the-job-training, working with the aircraft being used in flight training. In addition to the ramp work, there are lectures built around colored slides and a model of the airplane on which the areas which figure in this work are clearly marked. This training is oriented toward "what-to-do" and "how-to-do-it" in specific areas. Procedures and techniques involved are spelled out in detail.

After the training, the supervisors return to their respective stations to train their own personnel. And, as a summary, after the supervisors have completed their training job, an instructor visits the station for a review just prior to start of 880 service.

Two documents are used in this work, a familiarization guide on the aircraft in general and a ground handling guide. These go to the using stations for training and reference.

In this area, Delta is studying the possibility of using pocketsize manuals for ramp workers, providing them with a ready reference, rather than a larger document which is not handy to carry while working. Looseleaf provisions for updating might be used to further enhance the document's value.

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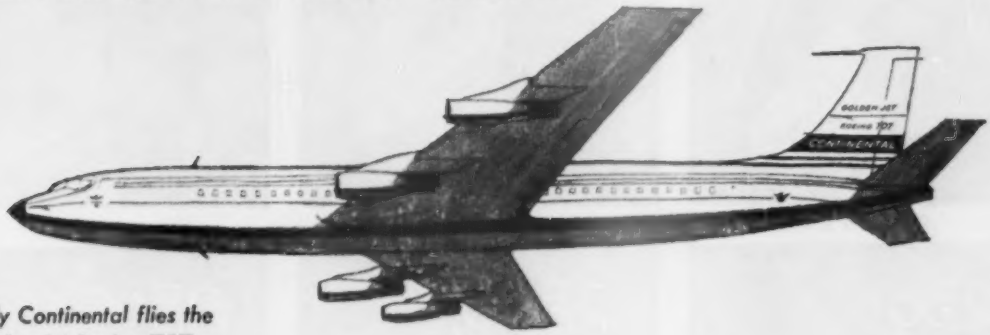

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The Standard Reference of
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A MESSAGE FROM THE PRESIDENT

Through the medium of words, statistics, and illustrations, this report records the first full year of the jet age—1959. It cites in detail the accomplishments of the United States' certificated scheduled airlines and the amazing response of the public to their efforts.

Unquestionably, as progress, growth and public usefulness can thus be recorded, 1959 was a most eventful year.

As I look back a decade or so to the forecasts of what the airlines would do in the "Fifties," I'm amazed at how far performance exceeded the predictions. The U. S. airlines carried 16 million passengers in 1949. Optimistic was the forecast that had that number doubled within the decade. The 1959 passenger total, however, was almost 56 million, an increase of 250%.

The development of airfreight, a formidable challenge in the absence of specific cargo aircraft, nevertheless has been substantial. In 1949, the airlines carried 113 million ton miles of freight. Last year, the total was just under 600 million ton miles.

That same year of 1949 saw the airlines achieve a safety record of 1.39 fatalities per 100,000,000 passenger miles of domestic travel. But last year, the greatest traffic year in airline history by far, the safety rate improved to 0.7, or a fraction of one fatality per 100,000,000 passenger miles.

During the same ten-year period, during which the price of almost everything you bought increased considerably, airline prices remained almost unchanged. In fact, the Government does not mint a coin small enough to reflect the change, not even the penny. The average fare for a passenger to fly one mile is now but 3/10ths of one cent higher than it was ten years ago.

How has this been possible when, for example, consumer prices rose 21% and public transportation prices rose 61%? The answer is this: airline managements' constant attention to increased efficiency and productivity and their continued willingness to invest private capital in the best technology could offer. By this approach, unit costs have been held down, thus offsetting, for the most part, the general increase in the cost of doing business.

Yes, it has been an impressive demonstration of progress as thus recorded. But facts and figures such as these, comprehensive and revealing as they may be, cannot tell the whole story. The jet age, for example, is infinitely more than the establishment of new traffic records or the fact that travel and shipping habits are changing. It is a whole new era in which has been introduced such things as these:

- — new motivations for human activity and, accordingly, new human activities;
- — new methods for doing business and, in fact, new businesses; and
- — history-making concepts of political and diplomatic statesmanship.

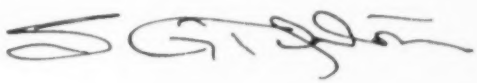
In some degree, the life of each man, woman, and child is affected by the progress of the nation's airline industry.

A blending of seemingly intangible facts such as these with the recorded events herein make up the true story of the jet age, to date. Of course, proper perspective is necessary, for this is only the beginning of the jet age, of the new era which the airlines have launched.

For example, more than half of the 600-plus jet-powered aircraft ordered by the U. S. air carriers remains to be delivered during 1960, 1961, and 1962. This year, deliveries are occurring at a rate of one every 44 hours.

The airlines started preparing for this new era years ago. And there is much in the way of progress in store for the future. The airlines are preparing for that, too. They are preparing and paving the way for continued world leadership in this field because it has become vital in the age we have entered.

Our Government with its many regulatory powers over this industry, with its countless decisions and policies which affect it, must see to it that this progress is assured for America. The climate must be one of encouragement—there must be opportunity for our air transport system to fulfill the role history has given it.



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Definition of Terms

Passenger Miles and Ton Miles

AVAILABLE SEAT MILES FLOWN. Total seat miles available for sale in scheduled service.

AVAILABLE TON MILES. Total ton miles of lift capacity available for sale in scheduled and charter service.

CHARTER FLIGHT. Transportation of passengers or property on other than scheduled and designated extra section flights.

EXPRESS TON MILE. A ton of express flown one mile.

FREIGHT TON MILE. A ton of freight flown one mile.

PASSENGER MILE. One passenger flown one mile.

PASSENGER LOAD FACTOR. The percentage of available seat miles actually sold in scheduled service.

PASSENGER TON MILES. Passenger miles converted to ton miles. (See definition of revenue ton miles.)

REVENUE PASSENGER MILES. The number of fare paying passengers flown times the length of trip in miles. This is the amount of available seat miles sold.

REVENUE PLANE MILES. Aircraft miles flown in scheduled service.

REVENUE TON MILES. The ton miles sold in scheduled and charter service. In the construction of this traffic measure passenger miles are converted to ton miles on the basis of about 10 to 1. That is, ten passengers with allowable free baggage are accepted as equalling one ton.

SEAT MILE. One passenger seat, filled or unfilled, flown one mile.

TON MILE LOAD FACTOR. Percentage of available ton miles sold in scheduled and charter service.

U. S. MAIL TON MILE. A ton of mail flown one mile. The mail figures are in two categories. These are defined as Priority and Non-Priority. Priority mail includes air mail and air parcel post. Non-priority mail is first class mail that moves in air service. At present non-priority mail is being flown on an experimental basis between certain selected cities.

Revenues and Profit and Loss

EXPRESS REVENUE. Revenues accrued from the carriage of express.

FREIGHT REVENUE. Revenues accrued from the carriage of freight.

INCOME TAXES. Federal Income taxes.

NET OPERATING INCOME. The total operating revenue from air transportation services less the operating expenses (see definition of Operating Expenses). Net Operating Income is before taxes and interest charges and does not include non-operating items.

NET PROFIT OR LOSS. Net income after Federal income taxes—the amount available for dividends or investment in the business.

OPERATING EXPENSES. The expenses incurred in the conduct of the business except for such items as debt financing and other non-operating items.

OTHER REVENUE. All other revenues, including excess baggage, chartered services, foreign mails, penalties for failure to cancel reservation, service charges on non-revenue transportation of employees and special services such as photography and crop dusting.

PASSENGER REVENUES. Passenger revenues from scheduled operations.

PUBLIC SERVICE REVENUES. Payments by the Federal Government to insure air service to communities in the United States and its territories which could not otherwise afford it; to maintain essential international air routes which are not yet self-supporting; and to develop helicopter service.

PROFIT MARGIN ON SALES. Net profit after interest and after taxes as percent of operating revenues.

RATE OF RETURN ON INVESTMENT. Total return, i.e., net profit plus interest paid on long term debt, as percent of average investment. Investment is the average of total net worth (stockholders' equity) plus long term debt at the beginning and end of the year.

U. S. MAIL REVENUE. Service revenue for the transportation of mail. This is the amount paid by the Post Office to purchase air transportation for mail, and is not subsidy.

FACTS AND FIGURES

21st Edition, 1960

The year 1959 was the first full year of the jet age and the first year of scheduled air transportation under the new Federal Aviation Act. The industry as shown in the text and tables flew more people, more goods and more mail than ever before. The tables this year contain the year 1950 and five consecutive years 1955-59 so that it is possible to see the industry's growth in public usefulness in the past decade. Revised data filed by scheduled air carriers with the Civil Aeronautics Board are the major source of the statistics.

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1959 – FIRST FULL YEAR OF THE JET AGE

Remarkable achievements in public service and enthusiastic public response to that service marked the first full calendar year of jet age operations by the nation's certificated scheduled airlines.

With national reliance on a sound air transport system reaching a new high level, more people, more goods and mail were flown than in any previous year. Significantly, 1959 was the eighth consecutive year that the airlines maintained a safety rate of less than one fatality per 100,000,000 passenger miles.

Some of the specific 1959 results achieved by the U. S. carriers, who are responsible for about two-thirds of the world's total civil air traffic, are:

- 55,900,000 passengers, almost 7,000,000 more than in 1958.
- 36.3 billion passenger miles, five billion more than in 1958.
- 589,487,000 ton miles of freight, up 88,000,000 over 1958.
- 200,279,000 ton miles of U. S. mail, a one-year gain of 22.7 million.
- 56,606,000 ton miles of express, up 8,000,000 in one year.

Total operating revenues of all U. S. scheduled airlines reached a record $2,607,844,000 last year, a gain of 16.5% over 1958. Money paid out by the airlines in operating expenses also reached a new high of $2,486,350,000, or 16.7% more than in 1958.

Net profit, after taxes and interest, for all carriers was $70,133,000 last year, up from the 1958 net of $49,520,000. Net profit was less than the $78,725,000 earned in 1955, however, even though last year's revenues exceeded those of 1955 by about $1,000,000,000.

The Jet Fleet: At the end of 1959, the U. S. certificated carriers operated a fleet of 1,894 aircraft. Included were 84 pure jet aircraft and 213 prop-jets.

THE AIRLINE STORY

Ever Increasing Usefulness Over The Years

All classes of Certificated Air Carriers	1939	1949	1959
Number of Airlines	23	45	56
Cities Served (excluding Alaskan points) [2]	286	638	721
Aircraft in Service	347	1,083	1,908
Seats Available (Daily)	5,100	35,900	109,710
Cruising Speed of Fastest Transport	220 mph	315 mph	615 mph
Number of People Employed	13,300	76,000	162,029
Total Airline Payrolls	$24,000,000	$349,000,000	$1,200,000,000
U. S. Mail Ton Miles	8,610,000	61,144,000	200,279,000
Number of Passengers Carried	1,864,000	16,723,000	55,875,000
Average Fare	5.62¢	6.23¢	5.93¢
Ton Miles of Freight Carried	2,713,000 [1]	112,500,000	589,487,000

[1] Freight and Express combined.

[2] Early figures for Alaska not available but in 1959 there were 242 points served.

This year, U. S. aircraft manufacturers will deliver 155 additional pure jets to the nation's certificated airlines, raising the total jet fleet to 239 planes. Also 51 prop-jets will be acquired raising that total to 264.

Orders for many of these new planes were placed by the airlines four and five years ago in an investment in progress totaling approximately $3,000,000,000. The planes being added

during 1960 alone will reflect an investment of well over $1,000,000,000.

Over 100 additional jet-powered planes have been ordered for delivery in 1961 and 1962.

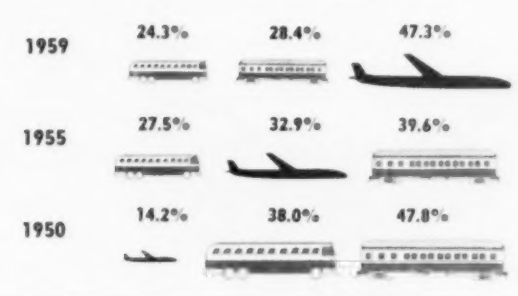
The Transportation Tax: Congress in 1959 took action to reduce the Federal tax on passenger travel from 10% to 5%, effective July 1, 1960. Currently, there is strong Congressional sentiment to eliminate the tax entirely on that date. But the Administration has not only opposed elimination but wants it increased again to 10% on July 1.

The tax was first levied in 1941 as a wartime measure to discourage travel on transportation facilities essential to the war effort. It is added to regular fares for intercity passenger travel on buses, trains, and commercial airliners.

As one leading Congressman put it, the tax discourages travel on commercial carriers and thus places a heavy burden upon one of the nation's most vital resources. Said another: "It continues to burden the public and to threaten the well-being of an industry essential to the national defense."

Airlines—Intercity Passenger Miles: The first year of the Jet Age saw the airlines pull away from railroads and buslines in domestic intercity, passenger-mile competition. A poor third in this competition just ten years ago, the airlines last year accounted for 47.3% of the total common carrier traffic. At the current rate of increase, the airlines in 1960 will surpass the combined total of train and bus passenger miles in this market.

AIRLINES NOW NO. 1 IN U.S. TRAVEL
based on
Inter-city, common carrier, Passenger Miles



Mail: On May 15, 1918, a pouch of mail was flown 250 miles between New York and Washington. Mail service by air was thus begun. Last year a network of 47 certificated, scheduled airlines transported over 200,000,000 ton-miles of airmail and 4¢ letters, cards and parcel post all over the U. S. and, in fact, all over the free world.

In Congress last year, Postmaster General Arthur E. Summerfield added emphasis to this phase of the changing American scene. Citing the "rapidly changing pattern of our national transportation system," Mr. Summerfield noted the cutback in railroad service "at a time when we are literally bursting at the seams with a far greater (mail) volume than ever before, generated by population increases, industrial expansion, and the growth of new communities many of which are not on rail lines."

"If the Department is to maintain a dependable intercity mail service for first class and other preferential mail," the Postmaster General told Congress, "*the only solution lies in appropriate use of air transportation.*"

Airfreight: Airfreight occupied a prominent role in the first full year of the jet age. The 589,487,000 ton miles of freight traffic carried by all U. S. certificatd airlines was an all-time high up 17.5% over 1958.

Much interest was stimulated in the past year in connection with the need for development of a modern civil cargo fleet to serve both the needs of commerce and the national defense. Many late-model piston-engined planes were converted by the carriers from combination type planes to all-cargo configurations.

Service-wise, the airfreight field was highlighted by national attention to the unique "total distribution cost" technique. Through this airline-developed technique, manufacturers found that airfreight service meant savings in total distribution costs beyond or apart from transportation rate considerations. Some firms completely realigned their businesses, eliminated warehouses and warehouse expense, because of the advantages of airfreight service.

Wiser's Report: A concept of Federal economic regulation geared to the specific characteristics of the airline industry was advanced in 1959 by Civil Aeronautics Board Examiner Ralph L. Wiser. In his initial decision in the pending General Passenger Fare Investigation, the Examiner concluded:

- That a strong air transport system is required in the public interest.
- That the multi-billion dollar jet age commitment by airline management reflected "sound business judgment."
- That the airlines are unique among utilities in their profit allowance requirements.
- That profits for the past few years have been "well below a reasonable level."

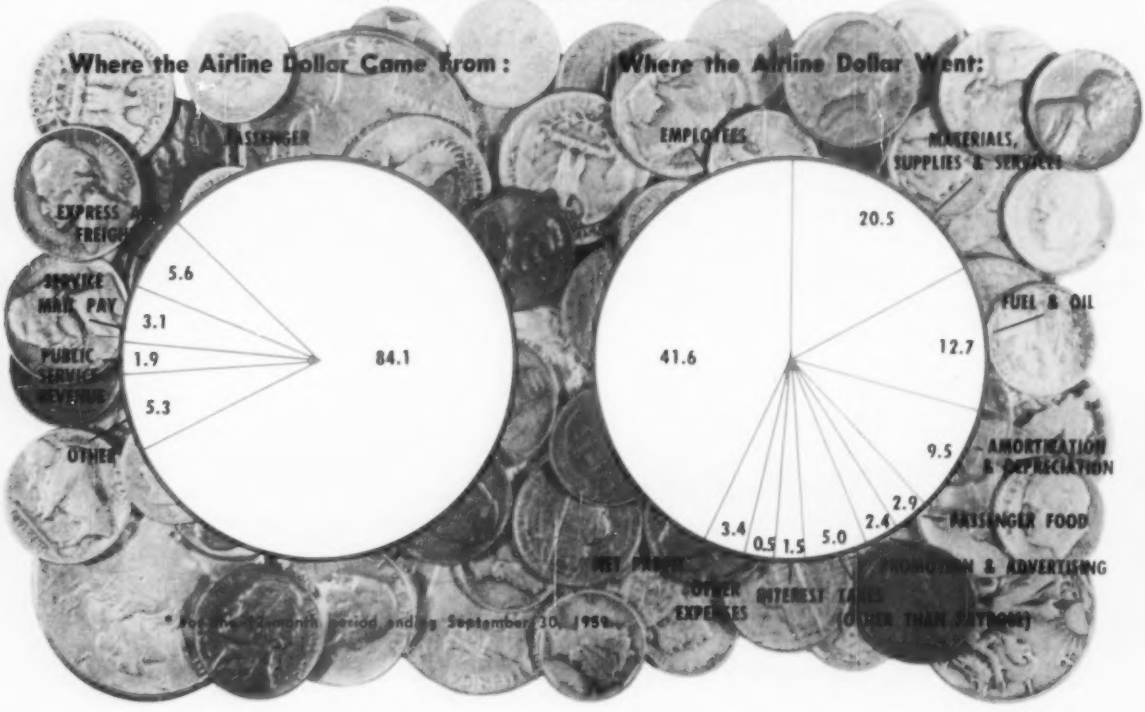
The vast amount of data and evidence compiled in the almost 4-year-old Investigation, according to Examiner Wiser, "presents a very favorable picture for the air carrier industry in comparison with other regulated and non-regulated industries. It has constantly increased its efficiency while producing transportation service which has been continuously better in speed, comfort, and convenience."

The Examiner found that the domestic trunk airlines' rate of return on investment should average between 10% and 12% for the most current 5-year period. However, for the 5-year period through 1958, the average was only 8.61% and in 1959 it fell even lower to 7.2%.

Measured in terms of net profit per dollar of gross revenues, or "profit margin," the airlines earned only 3.3% or 3.3 cents per dollar of revenue in 1959. Thus, despite a substantial increase in business, the airlines' profit margin was well under that earned in 1955 or even 1950.

The average corporation, for example, enjoys a profit margin of about 5¢. The nation's railroads whose financial condition has been widely noted, had a profit margin over twice as great as the airlines.

THE 1959* AIRLINE DOLLAR



In terms of actual dollars, it is significant to note that although the airlines' 1959 revenues were about $685 million more than in 1955, net profit after taxes in 1959 was about $4 million less.

In view of this situation, and the airlines' continuing need for additional capital, Examiner Wiser found that airline fares should be increased about 2% above present levels, or about 1/10th of a cent per passenger mile.

Final decision in this Investigation by the full five-man Civil Aeronautics Board was expected sometime during the first half of 1960.

THE AVERAGE SECRETARY KNOWS THAT AIR TRANSPORTATION IS A BETTER BUY . . .
44% farther in 1/2 the flying time
In 1950 she worked one week to travel
993 miles
BUT
In 1959
1431 miles

Since 1950 the average airline fare per passenger mile has increased only 3/10ths of one cent while the speed and efficiency of the service advanced substantially. During the 1950-59 period, public transportation prices generally rose 61%.

MATS: A proposal by the Department of Defense and approved by President Eisenhower contemplates providing the U. S. with a vastly improved defense airlift. Specifically, it calls for:

- Operation of the Military Air Transport Service (MATS) in a manner to meet military hard-core requirements in a general war and emergencies.
- Modernization of MATS' fleet along these hard-core lines.
- Utilization of the civil airlines to the maximum extent to satisfy the Defense Department's overseas air logistics support requirements.

"MATS ideally should perform only the hard-core mission," said the Defense Department, "leaving to the commercial carriers the job of providing airlift for routine logistic supply and normal personnel movements in conformance with criteria prescribed by the Department of Defense."

In the past, MATS has been attempting to do both jobs at once.

Significantly, of the routine MATS traffic in the current fiscal year, 93 per cent of the passenger and 89 per cent of the cargo traffic will be carried by the Government airline over the routes and between areas served regularly by the U. S.-Flag airlines.

Recently, ATA president Tipton advised Congress that the U. S.-Flag scheduled airlines "presently have the capability to handle the vast majority of MATS' passenger requirements and a substantial part of the cargo requirements."

Bomb Hoax: A cooperative effort involving the airlines, Government, and press is underway to stamp out the activities of so-called "bomb hoaxers."

Airline employees have been alerted and instructed how to cope with these individuals whose method is usually the anonymous phone call and the "tip" or threat that a bomb is aboard a plane.

This results in halting planes on the ramp, or even calling them back if in flight. Passengers are unloaded, baggage and cargo are examined, and then, some time later, the flight is sent out again.

Annoying and sometimes serious inconvenience to the passengers, and expensive delays for the airlines are the net results of these hoaxes.

The ATA has an award program involving cash payments up to $1,000 for airline employees who, in the opinion of proper authorities, assist in apprehension of a bomb hoaxer. Local police authorities and the Federal Bureau of Investigation are extremely active in stamping out this perverted practice.

In addition, a more severe criminal statute is now pending in Congress. Introduced by Senator John Marshall Butler (R.-Md.), it would

increase the penalty for convicted bomb hoaxers to $5,000 fine or 5 years in jail, or both, from the present $1,000 fine or 1 year in jail, or both.

The scheduled airlines also are actively studying the whole question of sabotage to aircraft. "While sabotage has only been a proven cause of airline accidents in rare cases in this country," ATA president Tipton said recently, "the airlines are unwilling to overlook even this remote threat to the safety of their passengers and crews."

In one action announced recently the ATA retained the Stanford Research Institute to conduct a thorough investigation "to gain more specific knowledge of the anatomy of explosive devices and their detection."

AIRLINE SAFETY

Last year was the eighth consecutive year in which the domestic airlines' rate of safety was less than one passenger fatality per 100,000,000 passenger miles. And it was the seventh consecutive year of similar achievement in the international field.

Today, it is three times as safe to travel by domestic scheduled airline as by automobile. During 1958, latest period available, there were 24,200 auto and taxi passenger fatalities, a rate of 2.3 fatalities per 100,000,000 passenger miles. On the average, there are more highway fatalities every two weeks than occurred in the entire 10-year period of the 1950's on the domestic scheduled airlines.

Last year, with airline passenger volume at an all-time high, the domestic air carriers' safety rate was 0.72 fatalities per 100,000,000 passenger miles. In international service it was 0.86.

DOMESTIC TRUNKLINES

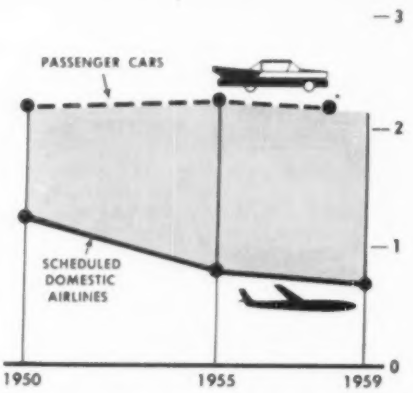
Record traffic volume in 1959 on the domestic trunk airlines gave added emphasis to the reasons why airlines continually improve and enlarge their airlift capacity.

The trunkline fleet of just ten years ago, for example, would have accommodated only about half of last year's total traffic. The 1959 total was 3,166,800,000 revenue ton miles (passengers, cargo, and mail), up 15% over the 1958 total. If the public had to rely on the 1950 airline fleet, about 1,500,000,000 ton miles of this traffic, almost half, could not have been carried.

The passenger volume alone in 1959 was much greater than the airlift capability of just five years before. Last year's revenue passenger miles were 28,127,200,000, also up 15% over 1958. The available seat-mile capacity of the 1954 fleet—just before jet aircraft orders were placed—would have been over *3,000,000,000 seat miles short* of meeting last year's actual passenger requirements.

THE AIRLINE SAFETY STORY

Fatalities Per 100,000,000 Passenger Miles



* N.A. (Figure shown reflects 1958 rate of 2.3)

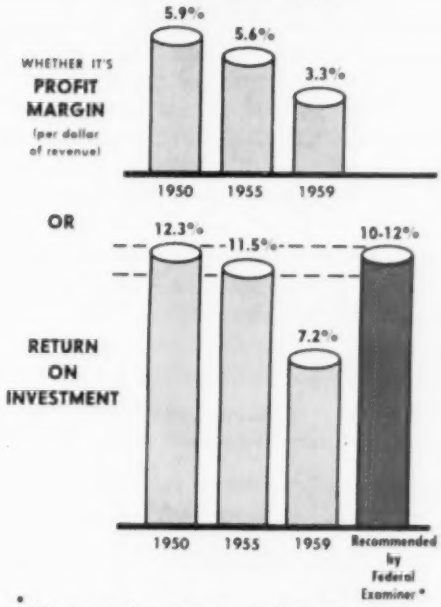
The same is true of the future, too. Thus, the record capacity made available in 1959 by the trunklines — 45,793,200,000 seat miles — would fall far short of meeting the absolute demand anticipated by the Government a few years from now.

For example, a recent Civil Aeronautics Board forecast estimates that domestic airline passenger miles in 1964 will total 48.3 billion; in 1965, 53.0 billion. This is a range of from 2.5 billion to 7.2 billion passenger miles more than the record capacity made available by the trunks in 1959.

And, of course, providing airlift capacity sufficient only to meet absolute demand is both

impractical and inadequate. For one thing, demand for air service is not uniform day-in and day-out. It is usually greater on week-ends than during the week. It is greater on holiday week-ends than on normal week-ends. In some markets, it is greater in the winter than in the summer; in others, the reverse is true. Thus, sufficient reserve capacity must be available to cope with the flexibility of demand.

DOMESTIC TRUNK AIRLINES PROFIT TREND DOWN



* "The history shows that when earnings of a particular year fall below 10%, the danger point of financial difficulties is at hand," according to Civil Aeronautics Board Examiner Ralph L. Wiser. An average return of between 10% and 12% for five-year periods was found "reasonable" and required by the domestic trunk airlines in the Initial Decision in the General Passenger Fare Investigation.

National defense considerations also require the civil airlines to have sufficient reserve capacity to meet unexpected emergencies such as the Korean War, Berlin Airlift, etc., or major conflicts such as World War II. In this way, the airlines can serve national defense requirements with little or no disruption to the nation's commerce or postal service.

Thus, in the advance planning by airline management that goes into major re-equipment programs—such as the current transition to jets—factors considered include not only the present demand for service but continued growth in demand, good and efficient service to the public, and potential national emergencies that may arise.

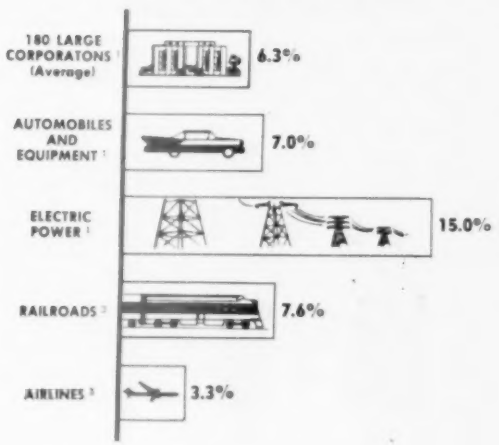
The ratio of reserve capacity to total capacity may fluctuate from year to year being affected by such variables as national economic conditions, aircraft manufacturers production schedules, national and world political developments, or a combination of these factors.

During a period of peak production by aircraft manufacturers in an airline re-equipment cycle, for example, the ratio of reserve capacity to total capacity tends to increase. However, as deliveries in a given cycle taper off, the constant increase in absolute demand restores the reserve capacity ratio to an average level.

During the past ten years, the ratio of reserve passenger capacity to total fluctuated from a low of 33% in the Korean War year of 1952 to a high of 40% in the recession year of 1958. Last year, the ratio declined to 38.5%.

Record Traffic: 1959 was a year of peak demand for scheduled airline service. The domestic trunks' passenger total was 44,489,000 or almost 5,000,000 passengers more than were carried in 1958.

AIRLINES PROFIT MARGIN COMPARED TO OTHER INDUSTRIES



[1] Based on 1st 9 months, 1959, Federal Reserve Bulletin, Feb. 1960

[2] Covers 113 Class I Roads, Moody's Transportation, P. 1663, Feb. 19, 1960

[3] Domestic Trunk Airlines

Airfreight ton miles totaled 282,473,000 or 17% more than in 1958. It is three times the annual volume of just a decade ago. Airmail volume last year was a record 98,496,000 ton-miles, up 12% in one year. In addition, non-priority or 4¢ mail carried by the airlines under a special Post Office Department experiment, increased to 17,918,000 ton miles, up 11%.

Financial Results: Total operating revenues of the trunk carriers were $1,798,000,000 in 1959, a gain of 18.8% over 1958. Total operating expenses rose 19.4%, however, to a new high of $1,692,800,000.

No new record was set in profits although last year's net of $59,900,000 reflected an increase from the 1958 total of $44,800,000. As stated, although the trunk airlines did $685,000,000 more business last year than in 1955, the 1955 net profit exceeded last year's by almost $4,000,000.

LOCAL SERVICE AIRLINES

The local service airlines, that segment of the U. S.-Flag airline system devoted to serving America's small and medium-sized communities and linking them with metropolitan areas, surpassed all existing records in 1959.

Operating over a 45,718-mile national route network, the local lines carried 5,214,000 passengers in 1959, a 22% increase over the previous record set in 1958. Revenue passenger miles last year totaled 1,023,500,000, or 25% more than in 1958.

Ten years ago, when the local carriers operated under temporary certificates in a Government experiment to see if small-town airline service was feasible, the locals carried about 1,800 passengers a day. Now, under permanent certificates resulting from an affirmative answer to the Federal experiment question, they carry over 14,200 passengers daily.

In addition to passenger traffic records set last year, the local airlines established new highs in all other forms of traffic. Airfreight reached 3,123,000 ton miles, up 39%; air express totaled 2,209,000 ton miles, up 22.5%; airmail totaled 1,693,000 ton miles, up 27%; and non-priority mail totaled 503,000 ton miles, up 27%.

Last year also marked the first time that total operating revenues passed the $100,000,000 mark. Actual total was $122,421,000, a gain of 28.9% over 1958. Total operating expenses in 1959 were $121,825,000, up 30.5% over 1958.

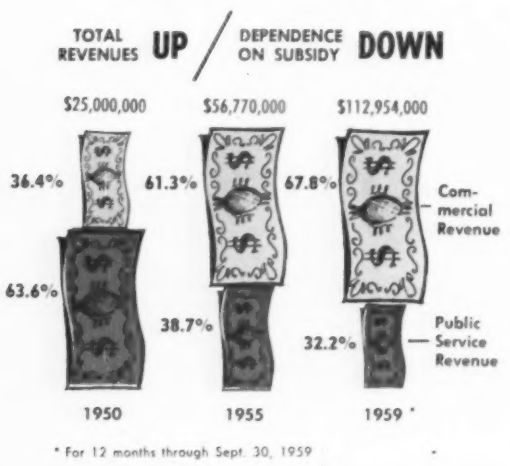
Net profit for the local carriers in 1959 was $74,000, compared to a 1958 net of $1,109,000.

Decreasing Dependence on Federal Aid: During the early experimental years of local airline service, approximately ¾ths of the carriers' revenues came from Federal funds or public service revenues. Now, the situation is almost completely reversed. According to 1959 figures, 67.8% of local service revenues came from commercial services, i.e., passenger, freight, express, and mail operations. Only 32.2% came from public service revenues.

Currently, local airline service is available to over 60,000,000 people in 564 communities. Well over 300 cities count on these carriers for their only regularly scheduled airline passenger, mail and cargo service.

"For many of these communities," ATA president Tipton noted recently, "local airline service has meant a new economic birth—the attraction of new industries, new outlets for their products, new markets to choose from. The carriers are important members of the communities they serve."

LOCAL SERVICE AIRLINES



* For 12 months through Sept. 30, 1959

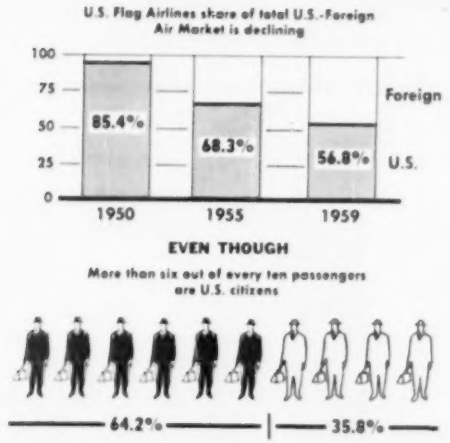
INTERNATIONAL AIRLINES

The United States international airlines established new traffic records in 1959 but faced increasingly stiffer competition from foreign airlines serving the U. S.-foreign market.

The 4,704,000 passengers carried by the American carriers last year was 12.6% more than the previous record total of 4,176,000 carried in 1958. Revenue passenger miles jumped 15.4% to a new all-time high of 6,894,200,000.

Despite these gains, foreign airlines continued to get an increasingly larger share of the growing market. Most passengers traveling between the U. S. and foreign countries are U. S. citizens. In 1959, the percentage of U. S. citizens to total travelers was 64.2%. Yet, foreign airlines serving the U. S. have increased their share of this market from 14.6% in 1950 to 43.2% in 1959. Conversely, the U. S.-Flag airlines' share dropped from 85.4% to 56.8% in the same period.

PASSENGER TRAFFIC BETWEEN THE UNITED STATES AND FOREIGN COUNTRIES



Meanwhile, substantial gains in cargo were registered by the U. S.-Flag lines last year. Airfreight reached a new high of 153,956,000 revenue ton miles, up 19% over 1958 volume, and almost 10 times the volume carried a decade ago. U. S. mail ton miles totaled 71,586,000 in 1959, an increase of almost 9% in one year.

The U. S. carriers generated record operating revenues of $565,056,000, up 11.5% over 1958. Total operating expenses climbed 10% to $547,052,000. Net profit was $12,579,000 representing a 2.2% profit margin on total revenues, compared with a 1958 net of $6,548,000, and profit margin of 1.2%.

HELICOPTER CARRIERS

The public usefulness of scheduled helicopter service was emphasized last year as the certificated helicopter lines in Chicago, Los Angeles, and New York showed a 60% gain in passenger traffic. A total of 366,000 passengers were carried in 1959, compared with 228,000 in 1958.

Significantly, passenger load factor (percentage of saleable seats occupied) showed the greatest one-year gain in helicopter history, rising to 51.51% in 1959 from 42.78% in 1958.

Total traffic, i.e., passengers, freight, mail, and express, climbed to a record 855,000 revenue ton miles last year, a gain of 44.6% in one year.

AIRLINES IN THE NEW STATES

ALASKA: Total traffic carried by the U. S. certificated airlines based and operating in the new State of Alaska was 42,200,000 revenue ton miles in 1959, a 28% gain over 1958. Included was an all-time high number of passengers, 347,000, 10.8% more than the previous year, and 10.1% more than the previous record set in 1956.

Revenue passenger miles reached a new high of 183,000,000 last year, 11.7% higher than the previous record set in 1958. Also at a new all-time high was U. S. mail traffic of 3,620,000 ton miles, 11.4% more than the 1958 record total.

The Alaskan lines also hauled 7,486,000 ton miles of freight last year, a 6.1% gain over 1958.

HAWAII: A record of 755,000 passengers were carried last year by the certificated airlines based in the State of Hawaii, a one-year gain of almost 32%. Total passenger miles increased 34% to a new high of 111,900,000.

Total revenue ton miles of all traffic increased

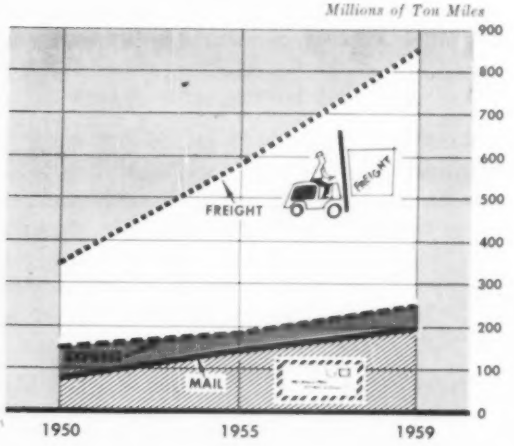
to 12,667,000, a 12.3% gain over the previous record set in 1958. In addition to the passenger gains cited, this included a 2.4% gain in airfreight with 1,625,000 ton miles carried in 1959 and a 12% gain in U. S. mail which totaled 75,000 ton miles last year.

ALL-CARGO AIRLINES

Approximately 31% of the airfreight carried by U. S. air carriers in 1959 was transported by the all-cargo airlines.

Actual freight volume for the cargo carriers was 140,817,000 ton miles, a 16% increase over 1958. U. S. airmail volume increased 200% to 6,129,000 ton miles, but non-priority mail volume fell off from 621,000 ton miles in 1958 to 161,000 in 1959.

AIRLINES CARGO REACHES NEW HIGH



USE OF THE AIRSPACE

Twenty years ago, the airspace above the 3,023,000 square miles of the United States appeared adequate. There was then less than 30,000 aircraft using the American sky and few of those planes flew faster than 150 miles per hour.

Today, there are an estimated 109,500 planes flying in the same airspace. In addition to this numerical increase, the hourly utilization of planes is higher today and, of course, speeds have increased tremendously.

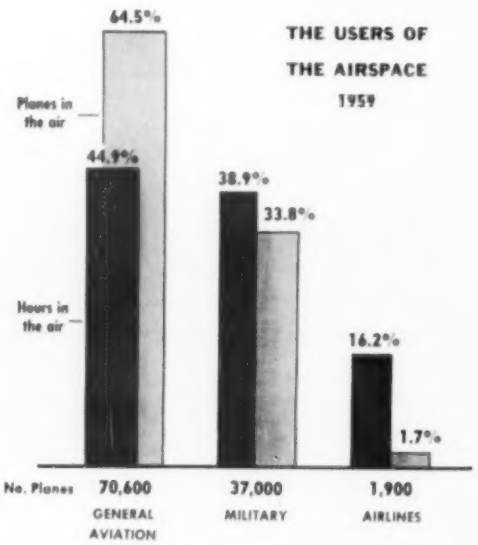
The largest number of planes using the airspace today is the 70,600 belonging to the nation's general aviation fleet, which represents 69.5% of the total planes and accounts for 44.9% of the total aircraft hours in the air.

Commercial airline planes total just under 1,900, or 1.7% of the total using the airspace. The airlines account for 16.2% of the total hours in the air.

The exigencies of national defense require extensive use of the airspace by the military, as is shown by the fact that 37,000 military aircraft, 33.8% of the total, account for 38.9% of the total hours.

In addition, essential air maneuvers—a necessity if the United States is to maintain its readiness status—requires priority military use of blocked-off areas of airspace. This is assured by an air traffic control function that keeps other aircraft out of those areas during the period of military use.

Other parts of the sky are also reserved for missile development, radio and transmission towers, and for natural preserves.



U. S. Scheduled Airline Industry

(For Selected Years, in Millions)

THIS TABLE SHOWS THE EVER INCREASING GROWTH IN THE SERVICES THE SCHEDULED AIRLINES ARE OFFERING TO THE PUBLIC AND THE INCREASING USE OF THIS SERVICE BY THE PEOPLE, THE GOVERNMENT AND SHIPPERS.

LOAD FACTOR IS THE PERCENTAGE OF CAPACITY WHICH IS SOLD.

	Available Ton Miles Flown	Revenue Ton Miles Flown	Ton Mile Load Factor (%)	Available Seat Miles Flown	Revenue Passenger Miles Flown	Passenger Load Factor (%)	Revenue Plane Miles Flown
Domestic Trunk Airlines							
1950	1,684.1	953.5	56.62	12,385.6	7,766.0	62.70	327.1
1955	3,882.7	2,160.1	55.63	30,001.3	19,217.2	64.05	564.0
1956	4,393.2	2,417.0	55.02	33,752.6	21,643.1	64.12	622.1
1957	5,150.4	2,720.0	52.81	39,838.2	24,499.5	61.50	711.1
1958	5,190.2	2,750.9	53.00	40,695.0	24,435.7	60.05	700.6
1959	5,949.3	3,166.8	53.23	45,793.2	28,127.2	61.42	743.5
Local Service Airlines							
1950	62.4	20.6	33.02	599.2	188.8	31.51	33.0
1955	121.9	55.3	45.36	1,161.4	523.3	45.06	50.9
1956	145.6	66.8	45.91	1,385.0	633.2	45.72	59.5
1957	170.7	78.5	46.00	1,653.8	747.3	45.19	67.3
1958	185.4	86.6	46.71	1,793.5	820.2	45.73	72.3
1959	238.5	108.9	45.67	2,309.2	1,023.5	44.32	85.4
Intra-Hawaiian Airlines[1]							
1950	10.9	5.7	52.20	100.1	57.7	57.66	4.3
1955	16.1	8.4	52.10	134.7	78.1	57.99	4.6
1956	16.0	8.5	53.03	147.9	83.9	56.70	4.6
1957	15.7	9.1	57.96	154.9	89.5	57.78	4.7
1958	18.4	11.3	61.15	143.1	82.7	57.76	4.4
1959	21.1	12.7	59.89	187.2	110.9	59.21	5.3
Helicopter Airlines *(in thousands)*[2]							
1950	189	63	33.33	.....	.....	.....	668
1955	434	195	44.93	1,708	628	36.77	1,148
1956	567	277	49.03	3,561	1,588	44.59	1,315
1957	1,056	448	42.42	8,049	3,272	40.66	1,604
1958	1,497	591	39.48	11,419	4,885	42.78	1,675
1959	1,759	855	48.61	14,517	7,478	51.51	1,899
International and Overseas Airlines							
1950	554.2	334.5	60.35	3,695.4	2,206.4	59.71	93.8
1955	984.6	633.8	64.37	7,012.1	4,410.8	62.90	130.7
1956	1,143.4	741.2	64.82	8,073.1	5,113.2	63.34	146.0
1957	1,292.9	827.0	63.96	9,038.1	5,751.7	63.64	155.7
1958	1,426.6	873.1	61.20	10,057.6	5,974.6	59.40	165.5
1959	1,573.7	1,026.4	65.23	10,473.3	6,894.2	65.83	164.5
Alaskan Airlines							
1950	19.7	10.2	51.79	54.0	22.4	41.60	5.4
1955	46.0	29.4	63.87	233.9	110.4	47.20	10.5
1956	66.9	44.8	66.98	284.1	137.0	48.21	11.3
1957	59.4	32.5	55.08	329.7	151.9	46.07	11.5
1958	59.9	32.9	54.89	369.0	163.8	44.39	11.5
1959	72.8	42.2	58.00	414.0	183.0	44.22	12.4

See Footnotes at End of Table on Page 98

Available Service and Utilization *(continued)*	Available Ton Miles Flown	Revenue Ton Miles Flown	Ton Mile Load Factor (%)	Available Seat Miles Flown	Revenue Passenger Miles Flown	Passenger Load Factor (%)	Revenue Plane Miles Flown
All-Cargo Airlines							
1950	80.2	59.5	74.20	.....	.....	.....	13.0
1955	184.0	135.1	73.41	.....	.....	.....	17.1
1956	321.5	248.8	77.38	.....	.....	.....	23.5
1957	431.7	336.9	78.04	.....	.....	.....	23.3
1958	383.8	319.3	83.20	.....	.....	.....	16.1
1959	369.9	332.7	89.93	.....	.....	.....	16.2
Consolidated Industry							
1950	2,411.7	1,384.1	57.39	16,834.3	10,241.4	60.84	477.2
1955	5,235.7	3,022.2	57.72	38,545.1	24,340.4	63.15	779.0
1956	6,087.1	3,527.4	57.95	43,646.3	27,612.0	63.26	868.4
1957	7,121.5	4,006.4	56.23	51,022.7	31,243.1	61.23	975.3
1958	7,265.7	4,074.7	56.08	53,069.6	31,481.9	59.32	972.1
1959	8,227.1	4,690.5	57.01	59,191.5	36,346.3	62.85	1,029.1

NOTE: Available Ton Miles and Revenue Ton Miles include charter operations; all other items are for scheduled service only.

[1] Has been carried in the past as Territorial Airlines.

[2] Helicopter passenger service began in 1953.

PERSONNEL EMPLOYED BY THE SCHEDULED AIRLINE INDUSTRY[1]

(1940 - 1959)

Year (Dec. 31)	Pilots and Copilots	Other Flight Personnel	Pursers, Stewards, Stewardesses	Communications Personnel	Mechanics	Aircraft and Traffic Servicing Personnel	Office Employees	All Others	Total
1940	2,279	33	1,036	193	5,413	4,277	7,689	1,131	22,051
1941	2,664	49	1,210	220	6,389	4,931	9,710	1,285	26,458
1942	3,146	241	1,131	1,610	12,882	7,384	11,083	2,236	39,713
1943	2,332	330	992	2,196	10,411	5,191	12,832	4,995	39,279
1944	3,345	277	1,516	2,501	9,963	5,748	15,234	4,023	42,607
1945	5,897	1,046	2,486	3,477	15,943	9,447	23,904	6,081	68,281
1946	7,220	1,503	4,421	5,031	23,376	12,770	31,587	10,646	96,554
1947	6,637	1,333	4,077	3,829	21,140	11,610	32,691	3,835	85,152
1948	6,926	1,515	4,142	3,661	21,828	11,662	31,145	3,729	84,608
1949	6,843	1,602	4,341	3,581	19,535	11,674	30,148	3,270	80,994
1950	7,277	1,521	4,427	3,403	19,606	12,256	31,138	3,158	82,786
1951	8,386	1,708	5,303	3,618	23,477	14,370	35,081	3,810	95,753
1952	8,770	1,852	5,859	3,653	26,162	15,588	37,894	4,294	104,072
1953	9,437	2,146	6,106	3,567	26,105	17,353	40,319	4,359	109,392
1954	9,495	2,525	6,363	3,332	25,173	17,855	40,670	4,128	109,541
1955	10,857	2,762	7,454	3,499	29,196	19,114	45,030	4,291	122,203
1956	11,386	3,384	8,097	3,605	30,962	20,657	49,336	4,076	131,503
1957	13,286	3,797	9,450	4,004	31,162	36,052	31,799	17,640	147,190
1958	12,897	3,667	9,811	3,978	29,580	37,256	32,003	17,958	147,150
1959[2]	14,627	4,434	10,317	4,462	31,535	45,117	33,270	18,267	162,029

[1] Data for Alaskan and All-Cargo carriers not included prior to 1959.

[2] These are preliminary figures as of September 30.

REVENUE TON MILES OF TRAFFIC CARRIED

U. S. Scheduled Airline Industry

(For Selected Years, in Thousands of Revenue Ton Miles)

THIS TABLE SHOWS, BY CATEGORIES, THE EVER INCREASING USE OF THE SCHEDULED AIRLINES BY PASSENGERS AND COMMERCE

	Passenger [2]	Priority U. S. Mail	Non Priority U. S. Mail [3]	Express	Freight	Charter Flights	Excess Baggage [4]	Total
Domestic Trunklines								
1950	737,771	46,315	.....	36,538	112,861	8,203	11,782	953,470
1955	1,825,631	71,859	14,175	49,603	174,017	5,737	19,046	2,160,068
1956	2,056,098	77,788	13,891	49,709	190,592	5,911	23,055	2,417,044
1957	2,327,334	82,057	15,137	42,752	218,432	6,335	27,983	2,720,030
1958	2,321,347	87,809	16,155	45,890	240,510	12,000	27,237	2,750,948
1959	2,672,081	98,496	17,918	53,106	282,473	13,271	29,422	3,166,767
Local Service Airlines								
1950	17,934	566	.....	623	696	653	118	20,590
1955	49,713	928	328	1,403	1,355	1,338	245	55,310
1956	60,156	1,192	344	1,687	1,624	1,520	320	66,843
1957	71,079	1,174	345	1,642	2,082	1,717	471	78,510
1958	78,055	1,330	395	1,801	2,241	2,196	575	86,593
1959	97,509	1,693	503	2,209	3,123	3,160	713	108,910
Intra-Hawaiian Airlines [1]								
1950	4,620	65	.....	119	529	304	56	5,693
1955	6,250	59	.....	N.A.	1,646	436	20	8,411
1956	6,710	63	2	.....	1,475	236	17	8,503
1957	7,259	63	1	.....	1,536	170	36	9,065
1958	6,611	67	2	.....	1,587	2,965	32	11,264
1959	8,880	75	.....	.....	1,625	2,057	30	12,667
Helicopter Airlines [1]								
1950	.....	63	.....	.....	.....	.....	.....	63
1955	60	90	.....	31	5	.....	3	195
1956	149	89	.....	31	7	.....	1	277
1957	311	92	.....	33	8	3	1	448
1958	463	83	.....	32	6	5	2	591
1959	710	87	.....	41	7	7	3	855
International and Overseas Airlines [1]								
1950	237,188	21,188	.....	44,513	16,050	5,730	9,825	334,494
1955	453,195	52,409	.....	243	90,598	19,701	17,648	633,794
1956	524,369	55,158	.....	.....	109,235	32,652	19,757	741,171
1957	589,510	57,265	.....	.....	123,280	36,188	20,771	827,014
1958	597,326	65,825	.....	.....	128,925	60,817	20,191	873,084
1959	688,518	71,586	.....	.....	153,956	91,396	20,978	1,026,434
Alaskan Airlines [1]								
1950	2,413	714	.....	.....	1,027	6,095	90	10,221
1955	11,868	2,279	.....	.....	7,300	7,773	152	29,372
1956	14,719	2,383	.....	.....	7,948	19,527	241	44,818
1957	16,002	2,695	.....	.....	7,201	6,344	271	32,513
1958	17,290	3,069	35	.....	6,937	5,291	298	32,920
1959	19,440	3,620	11	.....	7,486	11,384	304	42,245

See Footnotes at End of Table on Page 100

Revenue Ton Miles of Traffic Carried *(continued)*	Passenger [2]	"Priority" U. S. Mail	Non Priority U. S. Mail [1]	Express	Freight	Charter Flights	Excess Baggage [4]	Total
All-Cargo Airlines								
1950	.....	.....	.....	.....	58,420	1,125	.....	59,545
1955	.....	.....	318	.....	107,945	26,796	.....	135,059
1956	.....	381	1,188	1,266	140,420	105,526	.....	248,781
1957	.....	440	1,409	1,638	155,126	178,249	.....	336,862
1958	.....	2,040	621	1,112	121,382	194,104	61	319,320
1959	.....	6,129	161	1,250	140,817	184,227	79	332,663
Consolidated Industry								
1950	999,926	68,938	.....	81,793	189,438	22,110	21,871	1,384,076
1955	2,346,717	127,633	14,821	51,280	382,866	61,781	37,114	3,022,209
1956	2,662,201	137,054	15,425	52,693	451,301	65,372	43,391	3,527,437
1957	3,011,495	143,786	16,892	46,065	507,665	229,006	49,533	4,004,442
1958	3,021,093	160,222	17,207	48,835	501,586	277,379	48,396	4,074,718
1959	3,487,138	181,686	18,593	56,606	589,487	305,502	51,529	4,690,541

N.A. Not Available.

[1] Has been carried in the past as Territorial Airlines.

[2] Passenger ton miles for years prior to 1957 were revised to conform with "standard" passenger weights as prescribed by the CAB effective January 1, 1957.

[3] See definitions, page 3.

[4] Foreign mail carried by International and Overseas and All-Cargo airlines is included in Excess Baggage. Therefore, it is also reflected in Consolidated Industry Excess Baggage data.

[5] Helicopter passenger service began in 1953.

[6] Express and Freight combined.

AIRCRAFT OPERATIONS AT FAA AIRPORT TOWERS

1950-1959 (In Thousands)

Type of Flight Operation	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Military	2,384	2,852	2,983	3,712	4,409	4,957	5,472	5,910	5,565	4,545
General Aviation	9,585	9,618	7,965	7,719	8,015	8,540	10,021	12,129	14,037	15,008
Air Carrier	4,002	4,556	4,866	5,384	5,521	5,983	6,553	7,112	6,998	7,353
Total	15,971	17,026	15,814	16,815	17,945	19,480	22,046	25,151	26,600	26,906
% Air Carrier of Total	25.1	26.8	30.8	32.0	30.8	30.7	29.7	28.3	26.3	27.3

Air Carriers include scheduled and non scheduled operations.
Each landing is counted as an operation as is also each take off.

OPERATING REVENUES

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Dollars)

THIS TABLE SHOWS THE DOLLARS OF SALES THE SCHEDULED AIRLINES EARNED FOR THE VARIOUS SERVICES THEY RENDER.

	Passenger	U. S. Mail		Public Service Revenue [1]	Express	Freight	Other [2]	Total
		Priority	Non-Priority					
Domestic Trunk Airlines								
1950	430,098	46,311	.....	.....	12,569	21,698	13,433	524,109
1955	1,021,855	24,230	2,708	3,192	19,405	39,605	22,353	1,133,348
1956	1,142,197	28,937	2,654	2,609	18,101	42,173	26,160	1,262,831
1957	1,287,172	31,002	2,760	1,182	14,667	49,870	32,961	1,419,614
1958	1,362,992	33,039	3,076	2,386	16,140	57,351	38,265	1,513,249
1959[p]	1,632,131	37,138	3,415	.....	19,124	67,026	39,202	1,798,036
Local Service Airlines								
1950	10,303	16,581	.....	.....	230	212	544	27,870
1955	32,840	1,084	101	20,923	665	556	1,281	57,450
1956	40,166	1,004	102	23,211	775	750	1,704	67,712
1957	47,464	1,108	103	29,651	725	1,049	2,039	82,139
1958	56,488	1,273	90	32,746	809	1,183	2,364	94,953
1959[p]	72,989	1,467	155	41,916	985	1,735	3,174	122,421
Intra-Hawaiian Airlines								
1950	4,105	285	.....	.....	125	288	410	5,213
1955	5,686	48	.....	291	.....	752[3]	337	7,114
1956	6,042	51	1	288	.....	782	266	7,430
1957	6,975	51	2	72	.....	781	479	8,360
1958	7,063	54	.....	109	.....	776	1,391	9,393
1959[p]	9,476	61	1	168	.....	832	1,061	11,599
Helicopter Airlines								
1950	.....	791	.....	.....	.....	.....	7	798
1955	208	250	.....	2,710	100	23	64	3,355
1956	438	234	.....	2,833	115	28	63	3,711
1957	968	237	.....	3,567	101	36	123	5,032
1958	1,459	214	.....	4,369	101	31	115	6,289
1959[p]	2,310	225	.....	2,722	123	39	2,335	7,754

See Footnotes at Bottom of Page 102

Operating Revenues
(continued)

International and Overseas Airlines	Passenger	U. S. Mail Priority	U. S. Mail Non-Priority	Public Service Revenue [1]	Express	Freight	Other [2]	Total
International and Overseas Airlines								
1950	160,673	55,689	.....	.....	15,783	5,881	22,105	260,131
1955	294,828	25,639	.....	1,583	77	31,853	30,324	384,304
1956	342,553	26,926	.....	8,308	82	36,683	38,113	452,665
1957	377,655	28,365	.....	555	80	41,475	39,818	487,948
1958	385,999	32,655	.....	.....	145	43,802	43,939	506,540
1959[p]	432,742	35,146	7	.....	93	55,536	41,532	565,056
Alaskan Airlines								
1950	2,758	2,939	.....	.....	.....	639 [3]	3,102	9,438
1955	8,162	2,333	.....	5,618	.....	2,464	3,747	22,324
1956	10,200	2,477	.....	6,241	.....	2,754	7,680	29,352
1957	11,263	2,662	.....	6,369	.....	2,651	4,063	27,008
1958	12,530	2,915	.....	6,839	.....	2,659	3,981	28,924
1959[p]	14,638	3,266	2	7,473	.....	2,833	5,441	33,653
All-Cargo Airlines								
1950	.....	.....	.....	.....	.....	8,850	3,511	12,361
1955	.....	60	.....	.....	.....	18,640	8,335	27,035
1956	.....	144	220	.....	447	25,564	26,485	52,860
1957	.....	189	263	.....	545	29,281	55,050	85,328
1958	.....	1,048	128	.....	300	23,349	52,026	76,851
1959[p]	.....	2,457	23	.....	356	35,958	30,531	69,325
CONSOLIDATED INDUSTRY								
1950	607,937	122,596	.....	.....	28,707	37,568 [3]	43,112	839,920
1955	1,363,579	53,644	2,809	34,317	20,247	93,893	66,441	1,634,930
1956	1,541,596	59,773	2,977	43,490	19,520	108,734	100,471	1,876,561
1957	1,731,497	63,614	3,128	41,396	16,118	125,143	134,533	2,115,429
1958	1,826,531	71,198	3,294	46,449	17,495	129,151	142,081	2,236,199
1959[p]	2,164,286	79,760	3,603	52,279	20,681	163,959	123,276	2,607,844

[p] Preliminary

[1] Prior to October 1, 1953, Public Service Revenues were not reported separately.

[2] Other revenues include revenues from excess baggage, foreign mail and charter operations, and incidental revenues.

[3] Express and Freight combined.

DISTRIBUTION OF OPERATING EXPENSES

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Dollars)

THIS TABLE SHOWS HOW THE AIRLINES SPEND THEIR DOLLARS TO INSURE FAST, SAFE, ECONOMICAL FLYING OPERATIONS AND EFFICIENT PASSENGER AND CARGO HANDLING.

Explanation of New Classification of Operating Expenses

The classification of operating expenses is different from that used in prior years. Owing to a revision of the form on which the carriers report to CAB it is not feasible to bring forward beyond 1956 the expense tables previously published in Facts and Figures. For this reason the data shown herein for years prior to 1956 were recast for this publication into the format of the new reporting system—insofar as it was feasible to do so. The data shown for 1957 and 1958 are as reported by the carriers. Although the "matching" of prior years' data with 1957 and 1958 is not perfect, it is considered adequate for general use where precision is not required.

The classifications of expenses employed in past issues of "Facts and Figures" were grouped as follows to fit the new format:

NEW CLASSIFICATION	OLD CLASSIFICATION
Flying operations	Flying operations
Maintenance	Direct maintenance—flight equipment Ground and indirect maintenance
Passenger service	Passenger service
Aircraft and traffic servicing	Ground operations
Promotion and sales	Traffic and sales Advertising and publicity
General and administrative	General and administrative
Depreciation and amortization	Depreciation—flight equipment Depreciation—ground equipment

As pointed out above, this method of matching accounts is not perfect. The figures for 1957 and 1958 differ in the following respects from those shown for 1956 and earlier:

1) "Amortization of other deferred charges" dispersed throughout the accounts for 1956 and before, is grouped in "Depreciation and amortization" after 1956.
2) "Legal fees and expenses," dispersed in several accounts prior to 1957 is all in "General and administrative."
3) Payroll taxes and employee welfare insurance, included in "General and administrative" before 1957 are distributed to other appropriate accounts.
4) Airport ticket office expenses, included in "Promotion and Sales" for earlier years is under "Aircraft and Traffic Servicing."
5) Route extension and development expenses, not classified as operating expense in prior years, are included in "Depreciation and Amortization," after 1956.

	Flying Operations	Maintenance	General Services & Administration: Passenger Service	Aircraft & Traffic Servicing	Promotion & Sales	Administrative	Total G. S. & A.	Depreciation & Amortization	Total Operating Expenses
Domestic Trunk Airlines									
1950	132,060	87,400	30,870	68,541	62,645	33,651	195,707	46,371	461,538
1955	302,591	196,320	72,996	133,274	134,706	68,473	409,449	101,709	1,010,069
1956	340,670	239,530	83,953	152,928	159,366	79,462	475,709	106,321	1,162,230
1957	434,842	270,328	95,505	217,208	157,561	55,164	525,438	146,968	1,377,576
1958	437,515	286,126	101,223	231,109	165,944	56,949	555,226	139,256	1,418,123
1959[p]	504,848	346,422	130,730	275,169	198,318	65,583	669,800	171,729	1,692,799
Local Service Airlines									
1950	8,330	5,256	1,090	4,969	3,241	2,484	11,784	1,836	27,206
1955	18,080	10,384	2,687	9,563	9,287	4,485	26,022	2,278	56,764
1956	21,616	12,610	3,385	11,187	11,399	5,382	31,353	2,714	68,293
1957	26,509	16,418	4,028	21,160	6,089	4,938	36,215	3,758	82,900
1958	29,267	18,572	4,528	24,047	7,026	5,544	41,146	4,351	93,336
1959[p]	36,746	24,924	6,074	31,153	9,281	6,808	53,316	6,839	121,825

See Footnote, Page 105

Distribution of Operating Expenses *(continued)*

	Flying Operations	Maintenance	General Services & Administration					Depreciation & Amortization	Total Operating Expenses
			Passenger Service	Aircraft & Traffic Servicing	Promotion & Sales	Administrative	Total G. S. & A.		
Intra-Hawaiian Airlines									
1950	1,221	942	190	906	832	743	2,671	452	5,286
1955	1,942	1,278	245	1,258	1,045	964	3,512	603	7,335
1956	2,033	1,259	252	1,317	1,182	848	3,599	416	7,307
1957	2,212	1,422	278	1,521	1,265	868	3,932	515	8,081
1958	2,504	1,698	413	1,671	1,283	1,022	4,393	661	9,256
1959[p]	3,076	1,933	456	1,948	1,726	1,223	5,353	909	11,271
Helicopter Airlines									
1950	205	182	.....	98	2	112	212	133	732
1955	614	871	21	425	180	393	1,019	451	2,955
1956	697	981	21	544	312	496	1,373	605	3,656
1957	1,108	1,381	.....	.....	.....	.....	1,765[1]	911	5,164
1958	1,416	1,618	.....	.....	.....	.....	1,982[1]	946	5,962
1959[p]	1,686	2,027	.....	.....	.....	.....	2,358[1]	1,041	7,112
International & Overseas Airlines									
1950	70,980	43,440	14,589	31,618	36,514	22,170	104,891	29,012	248,323
1955	108,501	58,975	26,773	46,990	61,980	31,291	167,034	31,094	365,604
1956	125,613	72,069	31,053	51,583	70,822	33,808	187,266	34,593	419,541
1957	142,944	72,326	32,519	67,187	70,902	24,631	195,239[2]	50,359	460,868
1958	155,060	79,892	35,516	72,716	75,759	24,412	210,695[2]	50,824	496,471
1959[p]	161,157	89,555	42,762	80,503	85,866	27,617	238,127[2]	58,213	547,052
Alaskan Airlines									
1950	3,020	2,365	358	966	634	1,332	3,290	1,028	9,703
1955	7,191	5,273	773	2,701	1,593	1,519	6,586	1,120	21,706[3]
1956	9,959	5,744	964	3,702	1,831	1,894	8,391	1,364	27,166[3]
1957	8,669	6,215	854	2,779	1,042	853	10,065[3]	1,646	26,595
1958	8,998	6,228	920	3,321	1,068	1,195	10,678[3]	1,920	27,824
1959[p]	10,516	7,756	1,226	3,641	1,311	1,340	12,351[3]	2,749	33,372

See Footnotes, Page 105

Distribution of Operating Expenses *(continued)*

	Flying Operations	Maintenance	General Services & Administration: Passenger Service	Aircraft & Traffic Servicing	Promotion & Sales	Administrative	Total G. S. & A.	Depreciation & Amortization	Total Operating Expenses
All-Cargo Airlines									
1950	4,633	1,769	.....	1,033	1,979	1,047	4,059	329	10,790
1955	10,635	5,287	267	3,896	2,081	2,103	8,347	2,074	26,343
1956	21,677	11,662	1,614	6,353	3,883	3,454	15,304	3,155	53,879[2]
1957	36,563	18,969	3,618	12,450	4,064	4,395	25,203[2]	8,998	89,734
1958	31,929	17,903	2,503	8,878	2,612	4,388	19,145[2]	9,172	78,149
1959[p]	29,968	17,644	1,504	8,510	2,590	4,470	17,843[2]	7,464	72,919
CONSOLIDATED INDUSTRY									
1950	220,449	141,354	47,097	108,131	105,847	61,539	322,614	79,161	763,578
1955	449,554	278,388	103,762	198,107	210,872	109,228	621,969	139,329	1,490,776[2]
1956	522,265	343,855	121,242	227,614	248,795	125,344	722,995	149,168	1,742,072[2]
1957	652,847	387,060	136,802	322,305	240,923	90,848	797,855[2]	213,156	2,050,918
1958	666,689	412,037	145,103	341,742	253,692	93,510	843,265[2]	207,130	2,129,121
1959[p]	747,997	490,261	182,752	400,924	299,092	107,041	999,148[2]	248,944	2,486,350

[p] Preliminary.
[1] Detailed expense data not reported.
[2] Total is greater than sum of individual expense categories since segregation of expenses is not reported by all carriers.

U. S. AIRLINES' SHARE OF AIR TRAVEL BETWEEN THE UNITED STATES AND FOREIGN COUNTRIES[a]

(Data in Thousands)

	1950	1955	1956	1957	1958[b]	1959[b]
Total Passengers to and from U. S.	2,163	3,422	3,884	4,315	5,075	5,734
By Air	1,074	2,207	2,643	3,053	3,827	4,316
By Sea	1,089	1,215	1,241	1,262	1,248	1,418
Air Share of Total (Percent)	49.7	64.5	68.0	70.8	75.4	75.3
Air Passengers via U. S.-Flag Airlines	918	1,508	1,763	1,911	2,207	2,452
Air Passngers via Foreign-Flag Airlines	156	699	880	1,142	1,620	1,864
U. S.-Flag Share of Total Air Passengers (Percent)	85.5	68.3	66.7	62.6	57.7	56.8

[a] Exclusive of travel over land borders (except Mexican air travel), crewmen, military personnel, and travelers between continental United States and its possessions.
[b] Calendar year figures for 1959 and 1958; Fiscal year figures 1950-57.

Source: U. S. Department of Justice, Immigration and Naturalization Service, "Report of Passenger Travel Between the United States and Foreign Countries."

SUMMARY OF PROFIT OR LOSS

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Dollars)

THIS TABLE SHOWS THE EARNINGS OF AIRLINES WHICH WERE AVAILABLE FOR DIVIDENDS TO STOCKHOLDERS OR FOR RETENTION IN THE BUSINESS. IT ALSO SHOWS THESE DOLLARS AS A PER CENT OF SALES AND THE RATIO OF TOTAL RETURN TO INVESTMENT.

	Total Operating Revenues	Total Operating Expenses	Net Operating Income	Interest on Long-Term Debt	Other Non-Operating Income (Net)	Income Taxes	Net Profit or Loss [1]	Rate of Return on Investment [2] (%)	Profit Margin on Sales [3] (%)
Domestic Trunk Airlines									
1950	524,109	461,538	62,571	4,331	1,065	28,940	30,365	.....	.....
1955	1,133,348	1,010,069	123,279	6,540	16,388	70,024	63,103	11.8	5.6
1956	1,262,831	1,162,230	100,601	9,964	23,917	56,842	57,712	9.4	4.6
1957	1,419,614	1,377,576	42,036	16,201	18,651	23,076	26,988	4.9	1.9
1958	1,513,249	1,418,123	95,126	24,300	20,588	44,723	44,794	6.3	3.0
1959[p]	1,798,036	1,692,799	105,237	32,118	37,816	52,673	59,911	7.2	3.3
Local Service Airlines									
1950	27,870	27,206	664	86	(754)	390	(566)	.....	.....
1955	57,450	56,764	686	219	369	484	352	2.7	0.6
1956	67,712	68,293	(581)	376	106	(50)	(801)	(—)	(—)
1957	82,139	82,900	(760)	224	(472)	(51)	(1,153)	(—)	(—)
1958	94,953	93,336	1,617	808	267	394	1,137	7.9	1.2
1959[p]	122,421	121,825	596	1,821	81	(281)	74	5.0	0.1
Intra-Hawaiian Airlines									
1950	5,213	5,286	(73)	1	(61)	3	(138)	.....	.....
1955	7,114	7,335	(221)	106	210	8	(125)	(—)	(—)
1956	7,430	7,307	123	97	(14)	.....	12	3.3	0.2
1957	8,360	8,081	278	109	376	53	267	11.0	3.2
1958	9,393	9,256	137	164	(5)	.....	(115)	1.2	(—)
1959[p]	11,599	11,271	328	221	(2)	37	88	4.6	0.8
Helicopter Airlines									
1950	798	732	66	.....	(30)	8	28	.....	.....
1955	3,355	2,955	400	11	155	202	342	10.0	10.2
1956	3,711	3,656	55	23	(63)	8	(39)	(—)	(—)
1957	5,032	5,164	(131)	64	19	(55)	(111)	(—)	(—)
1958	6,289	5,962	327	94	15	113	491	11.4	7.8
1959[p]	7,754	7,112	642	79	31	288	503	10.6	6.5

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Summary of Profit or Loss
(continued)

	Total Operating Revenues	Total Operating Expenses	Net Operating Income	Interest on Long-Term Debt	Other Non-Operating Income (Net)	Income Taxes	Net Profit or Loss [1]	Rate of Return on Investment [2] (%)	Profit Margin on Sales [3] (%)
International and Overseas Airlines									
1950	260,131	248,323	11,808	2,524	4,347	3,623	10,008	.....	.....
1955	384,304	365,604	18,700	1,700	6,754	10,320	13,434	6.3	3.5
1956	452,665	419,541	33,124	3,000	8,169	17,792	20,501	8.2	4.5
1957	487,948	460,868	27,080	4,882	8,619	13,252	19,520	7.8	4.0
1958	506,540	496,471	10,069	5,759	8,090	5,427	6,548	3.2	1.3
1959[p]	565,056	547,052	18,004	8,444	11,602	9,663	12,579	4.6	2.2
Alaskan Airlines									
1950	9,438	9,703	(265)	35	(96)	37	(433)	.....	.....
1955	22,324	21,706	518	76	228	334	436	8.3	2.0
1956	29,352	27,166	2,186	222	(98)	870	996	15.1	3.4
1957	27,008	26,595	413	362	729	121	900	11.1	3.3
1958	28,924	27,824	1,100	418	350	673	391	5.7	1.4
1959[p]	33,653	33,372	281	657	497	350	(156)	3.1	(—)
All-Cargo Airlines									
1950	12,361	10,790	1,571	.....	224	591	1,204	.....	.....
1955	27,035	26,343	692	561	1,132	80	1,163	9.4	4.4
1956	52,860	53,879	(1,019)	488	4,539	1,210	1,822	7.0	3.4
1957	85,328	89,734	(4,406)	1,526	4,022	285	(2,207)	(—)	(—)
1958	76,851	78,149	(1,298)	1,672	1,655	1,351	(3,726)	(—)	(—)
1959[p]	69,325	72,919	(3,594)	1,597	2,300	(116)	(2,866)	(—)	(—)
CONSOLIDATED INDUSTRY									
1950	839,920	763,578	76,342	6,977	4,695	33,592	40,468	.....	.....
1955	1,634,930	1,490,776	144,154	9,213	25,236	81,452	78,725	10.8	4.8
1956	1,876,561	1,742,072	134,489	14,170	36,556	76,672	80,203	8.8	4.3
1957	2,115,429	2,050,918	64,511	23,368	31,665	36,683	44,202	5.1	2.1
1958	2,236,199	2,129,121	107,078	33,215	30,960	52,681	49,520	5.2	2.2
1959[p]	2,607,844	2,486,350	121,494	44,937	52,325	62,614	70,133	6.2	2.7

[p] Preliminary.

( ) Denotes reverse item.

[1] Net Profit or Loss for 1957, 1958 and 1959 is shown after "Special Items," which are not included in the detail. Therefore, the items do not add to the profit figures shown.

[2] Net Income before interest and after taxes as percent of average net worth and long-term debt.

[3] Profit as percent of revenues.

— ASSETS, LIABILITIES AND STOCKHOLDERS' EQUITY —

U. S. Scheduled Airline Industry

(As of Dec. 31, for Selected Years, In Thousands of Dollars)

THIS TABLE SHOWS WHAT THE SCHEDULED AIRLINES OWN AND WHAT THEY OWE

	1950	1955	1956	1957	1958	(Sept. 30) 1959
Domestic Trunk Airlines[a]						
Assets						
Current Assets	204,018	436,609	439,827	457,611	496,756	643,860
Investments and Special Funds	60,080	47,405	146,147	127,943	184,163	158,189
Flight Equipment	374,803	890,095	1,097,044	1,363,767	1,531,141	1,810,174
Reserve for Depreciation and Maintenance	173,183	478,482	553,793	639,019	756,023	823,013
Ground Property and Equipment	94,476	154,104	180,613	206,452	237,840	271,180
Reserve for Depreciation	40,947	77,622	89,217	101,001	115,769	128,619
Other Property	5,736	28,402	41,359	49,667	100,445	111,557
Deferred Charges	16,361	9,459	13,264	23,541	28,566	46,035
Other Assets	1,195	1,175	6,308			
Total Assets	542,539	1,011,145	1,281,552	1,488,961	1,707,119	2,089,363
Liabilities and Equity						
Current Liabilities	130,107	276,839	333,876	328,844	332,788	445,928
Long-Term Debt	135,842	198,916	324,071	469,486	588,730	781,402
Other Non-Current Liabilities				1,224	19,712	20,028
Operating Reserves	3,971	8,365	10,490			
Deferred Credits	17,327	22,886	37,646	51,480	78,818	103,808
Stockholders' Equity—Net of Treasury Stock	60,499	504,139	575,469	637,927	687,071	738,197
Preferred Stock	62,970	29,789	16,592	15,805	24,000	19,531
Common Stock	64,644	80,172	88,555	108,502	111,473	114,686
Other Paid-In Capital	67,179	141,839	178,058	215,292	236,105	255,094
Retained Earnings	255,292	252,339	291,872	298,328	315,493	348,886
Total Liabilities and Equity	542,539	1,011,145	1,281,552	1,488,961	1,707,119	2,089,363
Local Service Airlines						
Assets						
Current Assets	7,446	12,970	14,873	16,512	20,003	25,916
Investments and Special Funds	549	950	1,438	3,028	2,894	2,090
Flight Equipment	10,055	21,451	26,105	32,949	46,308	63,806
Reserve for Depreciation and Maintenance	5,021	11,096	12,628	16,825	20,445	24,769
Ground Property and Equipment	2,666	5,122	5,795	6,544	7,594	9,114
Reserve for Depreciation	1,020	2,555	2,949	3,556	4,119	4,650
Other Property	235	682	3,692	607	1,518	4,385
Deferred Charges	1,884	885	1,564	1,931	2,650	3,747
Other Assets	(28)	2	35			
Total Assets	16,766	28,411	37,925	41,190	56,403	79,639
Liabilities and Equity						
Current Liabilities	6,527	12,461	17,431	22,002	25,134	31,314
Long-Term Debt	1,485	4,013	7,800	8,656	18,106	31,986
Other Non-Current Liabilities				205	363	3,492
Operating Reserves	287	783	1,138			
Deferred Credits	148	21	303	264	220	244
Stockholders' Equity—Net of Treasury Stock	440	11,133	11,253	10,063	12,580	12,603
Preferred Stock	6,500	412	920	163	163	163
Common Stock	4,193	6,345	5,871	6,776	7,279	7,959
Other Paid-In Capital	(2,814)	4,324	4,891	4,863	5,733	6,982
Retained Earnings	8,319	52	(429)	(1,739)	(595)	(2,501)
Total Liabilities and Equity	16,766	28,411	37,925	41,190	56,403	79,639

[a] Balance sheet data for domestic trunk airlines reflect their international as well as domestic operations.
[b] Has been carried in the past as Territorial Airlines.

Assets, Liabilities and Stockholders' Equity
(continued)

	1950	1955	1956	1957	1958	(Sept. 30) 1959
Intra-Hawaiian Airlines[b]						
Assets						
Current Assets	1,743	1,068	1,241	1,964	2,102	2,531
Investments and Special Funds	228	19	15	113	13	72
Flight Equipment	2,724	5,744	6,057	5,932	7,786	11,015
Reserve for Depreciation and Maintenance	1,858	2,839	2,930	3,230	3,735	4,127
Ground Property and Equipment	1,008	1,177	1,276	1,354	1,501	1,631
Reserve for Depreciation	486	749	847	945	1,043	1,114
Other Property	69	41	17	133	77	191
Deferred Charges	228	180	169	182	633	825
Other Assets	5	.....	.....	.....	.....	.....
Total Assets	3,661	4,641	4,998	5,503	7,334	11,024
Liabilities and Equity						
Current Liabilities	921	1,329	1,520	2,011	2,884	2,108
Long-Term Debt	.....	1,835	1,702	1,635	2,681	6,202
Other Non-Current Liabilities	.....	.....	.....	.....	.....	.....
Operating Reserves	61	20	41	.....	.....	.....
Deferred Credits	91	1	68	23	2	61
Stockholders' Equity—Net of Treasury Stock	.....	1,456	1,667	1,834	1,767	2,653
Preferred Stock	2,768	.....	.....	.....	.....	1,000
Common Stock	372	1,981	1,981	1,981	1,287	1,296
Other Paid-In Capital	(552)	874	832	832	1,530	1,538
Retained Earnings	2,588	(1,399)	(1,146)	(979)	(1,050)	(1,181)
Total Liabilities and Equity	3,661	4,641	4,998	5,503	7,334	11,024
Helicopter Airlines						
Assets						
Current Assets	263	2,385	2,307	2,168	2,998	3,275
Investments and Special Funds	10	321	290	27	54	84
Flight Equipment	528	2,508	3,878	5,170	5,023	5,279
Reserve for Depreciation and Maintenance	286	1,313	1,645	2,336	1,621	2,242
Ground Property and Equipment	49	312	576	777	825	872
Reserve for Depreciation	21	137	197	311	396	480
Other Property	5	14	71	1	4	225
Deferred Charges	123	163	196	302	429	416
Other Assets	61	.....	.....	.....	.....	.....
Total Assets	732	4,253	5,476	5,798	7,316	7,429
Liabilities and Equity						
Current Liabilities	69	591	735	961	1,804	1,874
Long-Term Debt	.....	87	817	1,033	1,319	871
Other Non-Current Liabilities	.....	.....	.....	.....	1	1
Operating Reserves	.....	31	45	.....	.....	.....
Deferred Credits	.....	25	69	109	6	30
Stockholders' Equity—Net of Treasury Stock	320	3,519	3,810	3,695	4,186	4,653
Preferred Stock	375	.....	.....	.....	.....	.....
Common Stock	.....	677	702	734	771	771
Other Paid-In Capital	(32)	2,201	2,435	2,546	2,685	2,685
Retained Earnings	663	641	673	415	730	1,197
Total Liabilities and Equity	732	4,253	5,476	5,798	7,316	7,429
International and Overseas Airlines[a]						
Assets						
Current Assets	94,012	109,019	111,560	102,202	116,391	152,931
Investments and Special Funds	8,632	33,230	37,987	52,992	93,310	118,761
Flight Equipment	133,488	216,737	265,785	276,758	306,428	333,711
Reserve for Depreciation and Maintenance	55,495	99,787	114,074	132,185	149,995	166,475
Ground Property and Equipment	22,677	29,595	31,813	34,351	35,784	41,642
Reserve for Depreciation	11,738	18,424	18,614	20,741	22,348	23,986
Other Property	1,297	2,719	2,450	4,239	5,585	7,679
Deferred Charges	25,688	3,766	4,440	4,413	9,573	14,787
Other Assets	562	.....	.....	.....	.....	.....
Total Assets	219,123	276,855	321,347	322,029	394,728	479,050

See Footnotes at Bottom of Page 108

Assets, Liabilities and Stockholders' Equity
(continued)

	1950	1955	1956	1957	1958	(Sept. 30) 1959
Liabilities and Equity						
Current Liabilities	52,647	80,041	92,352	87,424	65,298	111,921
Long-Term Debt	41,250	60,481	83,406	85,653	167,234	199,810
Other Non-Current Liabilities	224			1,011	775	1,392
Operating Reserves	5,784	3,319	3,584			
Deferred Credits	19,803	5,646	6,058	6,648	8,445	7,252
Stockholders' Equity—Net of Treasury Stock	150	127,168	135,947	141,293	152,976	158,675
Preferred Stock	10,910	150				
Common Stock	62,829	13,622	13,792	16,310	15,462	15,444
Other Paid-In Capital	25,655	63,120	63,460	62,129	74,296	74,800
Retained Earnings	99,415	50,276	59,119	62,854	63,218	68,431
Total Liabilities and Equity	219,123	276,855	321,347	322,029	394,728	479,050
Alaskan Airlines						
Assets						
Current Assets	2,705	5,600	7,129	7,682	8,271	9,322
Investments and Special Funds	91	248	532	957	448	350
Flight Equipment	4,630	6,906	11,126	13,668	16,438	20,316
Reserve for Depreciation and Maintenance	3,127	4,981	5,539	6,080	6,601	7,346
Ground Property and Equipment	1,611	3,808	4,201	4,843	5,009	5,414
Reserve for Depreciation	635	1,531	1,808	2,138	2,417	2,670
Other Property	150	163	400	313	2,355	424
Deferred Charges	226	358	422	624	590	661
Other Assets	190	138	134			
Total Assets	5,841	10,709	16,597	19,869	24,093	26,471
Liabilities and Equity						
Current Liabilities	2,532	4,002	6,170	7,084	8,035	9,209
Long-Term Debt	486	765	3,360	4,942	7,565	8,031
Other Non-Current Liabilities				25	19	93
Operating Reserves	314	457	276			
Deferred Credits	56	200	42	104	282	211
Stockholders' Equity—Net of Treasury Stock	84	5,285	6,749	7,714	8,192	8,927
Preferred Stock	2,036				829	251
Common Stock	2,960	2,950	3,152	3,315	2,943	3,473
Other Paid-In Capital	(2,627)	3,605	3,613	3,629	3,655	3,686
Retained Earnings	2,453	(1,270)	(16)	770	765	1,517
Total Liabilities and Equity	5,841	10,709	16,597	19,869	24,093	26,471
All-Cargo Airlines						
Assets						
Current Assets	5,822	11,716	21,224	19,589	20,152	21,949
Investments and Special Funds	379	2,850	17,244	4,629	3,337	21,847
Flight Equipment	2,631	24,143	31,540	65,449	55,702	58,644
Reserve for Depreciation and Maintenance	833	7,575	9,188	17,500	17,522	20,343
Ground Property and Equipment	1,049	2,753	4,666	5,578	4,499	4,404
Reserve for Depreciation	561	1,354	1,833	2,382	2,257	2,530
Other Property	16	399	3,028	2,682	4,533	952
Deferred Charges	423	410	2,706	5,122	4,963	2,108
Other Assets		140	281			
Total Assets	8,926	33,482	69,668	83,167	73,407	87,031
Liabilities and Equity						
Current Liabilities	3,682	10,759	19,301	25,991	22,500	21,966
Long-Term Debt	1,531	7,598	16,813	25,121	17,509	30,282
Other Non-Current Liabilities				449	1,900	2,576
Operating Reserves	321	1,808	2,311			
Deferred Credits	45	235	2,277	3,257	3,325	3,513
Stockholders' Equity—Net of Treasury Stock		13,082	28,966	28,349	28,173	28,694
Preferred Stock	4,183	1,211	1,441	1,437	1,437	1,193
Common Stock	3,135	5,466	6,863	8,237	8,901	9,458
Other Paid-In Capital	(3,971)	4,304	14,341	15,701	19,257	21,508
Retained Earnings	3,347	2,101	6,321	2,974	(1,422)	(3,465)
Total Liabilities and Equity	8,926	33,482	69,668	83,167	73,407	87,031

Assets, Liabilities and Stockholders' Equity
(continued)

	1950	1955	1956	1957	1958	(Sept. 30) 1959
Consolidated Industry						
Assets						
Current Assets	316,009	579,367	598,161	607,728	666,673	859,784
Investments and Special Funds	69,969	85,023	203,653	189,689	284,219	301,393
Flight Equipment	528,859	1,167,584	1,441,535	1,763,693	1,968,826	2,302,945
Reserve for Depreciation and Maintenance	239,803	606,073	699,797	817,175	955,942	1,048,315
Ground Property and Equipment	123,536	196,871	228,940	259,899	293,052	334,257
Reserve for Depreciation	55,408	102,372	115,465	131,074	148,349	164,049
Other Property	7,508	32,420	51,017	57,642	114,517	125,413
Deferred Charges	44,933	15,221	22,761	36,115	47,404	68,579
Other Assets	1,985	1,455	6,758	.....	.....	.....
Total Assets	797,588	1,369,496	1,737,563	1,966,517	2,270,400	2,780,007
Liabilities and Equity						
Current Liabilities	196,485	386,022	471,385	474,317	458,443	624,320
Long-Term Debt	180,594	273,695	437,969	596,526	803,144	1,058,584
Other Non-Current Liabilities	224	.....	.....	2,914	22,770	27,582
Operating Reserves	10,738	14,783	17,885	.....	.....	.....
Deferred Credits	37,470	29,214	46,463	61,885	91,098	115,119
Stockholders' Equity—Net of Treasury Stock	61,493	665,782	763,861	830,875	894,945	954,402
Preferred Stock	89,742	31,562	18,953	17,405	26,429	22,138
Common Stock	138,133	111,213	120,916	145,855	148,116	153,087
Other Paid-In Capital	82,838	220,267	267,630	304,992	343,261	366,293
Retained Earnings	372,077	302,740	356,394	362,623	377,139	412,884
Total Liabilities and Equity	797,588	1,369,496	1,737,563	1,966,517	2,270,400	2,780,007

DOMESTIC INTERCITY PASSENGER MILES

(For Selected Years, In Millions)

	1939	1949	1955	1956	1957	1958	1959
Railroad Travel:[1]							
First Class	7,527	9,349	6,440	6,275	5,185	4,249	3,819
Coach	11,180	20,310	17,329	17,105	16,365	14,230	13,683[5]
Air Travel:[2]							
First Class	654	6,454	13,025	14,202	15,736	15,180	16,847
Coach	....	251	6,716	8,074	9,510	10,076	12,304
Motor Bus Travel [3]	9,100	22,411	16,562	16,409	16,377	15,083	14,700[5]
Total Common Carriers	28,461	58,775	60,072	62,065	63,173	58,818	61,510
Airline Share of Total	2.3	11.4	32.9	35.9	40.0	42.9	47.4
Private Automobile, Intercity [4]	234,700	376,313	585,800	617,700	644,800	663,700	670,000[5]
Total Common Carrier and Auto	263,161	435,088	645,872	679,765	707,973	722,518	731,510
Airline Share of Total Intercity Travel	0.2	1.5	3.1	3.3	3.6	3.5	4.0

[1] I.C.C., Statistics of Railways in the United States, 1959, Statement M-250.
[2] 1939, CAB, Annual Airline Statistics; 1949, CAB, Recurrent Reports on Traffic Statistics; 1955-1958, CAB, Monthly Reports on Air Carrier Traffic; 1959, Carrier Reports to CAB.
[3] 1939, I.C.C. Statement No. 531, Jan. 1953; 1949—1957, I.C.C. Transport Economics, Jan. 1960.
[4] 1939, NAMBO, Bus Facts, 20th Edition; 1949-1956, I.C.C. Transport Economics, May 1956 and Dec. 1959.
[5] Estimated.

REVENUE PASSENGERS CARRIED

U. S. Scheduled Airline Industry

(For Selected Years, In Thousands of Passengers)

	1939	1949	1951	1952	1953	1954	1955	1956	1957[2]	1958[2]	1959[2]
Domestic Trunk Airlines	1,713	14,021	20,621	22,759	26,137	29,526	34,511	37,598	40,270	39,513	44,489
Local Service Airlines	.....	678	1,481	1,736	2,032	2,423	2,897	3,453	3,943	4,265	5,214
Intra-Hawaiian Airlines	22	382	550	515	553	561	591	627	589	572	755
Helicopter Airlines	.....	.....	.....	.....	1	9	29	62	148	228	366
International and Overseas Airlines	129	1,520	2,038	2,362	2,682	2,888	3,376	3,888	4,065	4,176	4,704
Alaskan Airlines[1]	na.	122	157	194	220	225	264	315	309	313	347
TOTAL SCHEDULED AIRLINE INDUSTRY	1,864	16,723	24,847	27,566	31,625	35,632	41,623	45,943	49,339	49,067	55,875
AVERAGE LENGTH OF HAUL (Statute Miles)											
Domestic Trunk Airlines	397	469	495	533	547	550	557	576	608	618	632
International and Overseas Airlines	557	1,351	1,275	1,278	1,261	1,296	1,307	1,315	1,415	1,429	1,466

[1] Alaskan data for 1949 include charter flights. 1939 not available.

[2] Beginning in 1957 passengers were reported on a basis which yielded slightly lower figures than the basis used in prior years. This accounts in part for the typical increase of average length of haul in 1957 as compared to 1956.

AVERAGE REVENUE PER PASSENGER MILE

Intercity Common Carriers

(For Selected Years, In Cents per Mile)

	1939	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Domestic Scheduled Airlines[1]												
Coach or Tourist	.....	3.96	4.10	4.45	4.18	4.13	4.34	4.32	4.29	4.25	4.52	4.63
All Services	5.28	5.75	5.54	5.59	5.54	5.43	5.37	5.32	5.28	5.25	5.58	5.83
International Scheduled Airlines												
Coach or Tourist	.....	.....	.....	.....	.....	5.77	5.83	n.a.	n.a.	5.77	5.66	5.52
All Services	8.57	7.72	7.28	7.13	7.04	6.88	6.79	6.68	6.70	6.57	6.51	6.44
Railroads, Class I[2]												
First Class	2.33	3.14	3.25	3.27	3.35	3.38	3.35	3.31	3.39	3.68	3.75	3.84
Coach	1.80	2.41	2.47	2.47	2.53	2.53	2.50	2.47	2.56	2.71	2.76	2.77
Intercity Motor Buses, Class I	1.55	1.85	1.89	1.95	2.03	2.06	2.08	2.06	2.13	2.29	2.42	2.56[3]

[1] Trunk airlines, preliminary.

[2] 11 months 1959. Excludes commutation. Does not include payments to Pullman Company for seat, berth, etc.

[3] ATA estimate.

n.a. Not available.

Note: Average passenger fare is derived by dividing passenger revenue by revenue passenger miles.

AIRCRAFT OWNED AND ON ORDER

By U. S. Scheduled Airline Industry

(For Selected Years)

THIS TABLE SHOWS HOW THE SIZE AND TYPE OF AIRCRAFT USED BY THE SCHEDULED AIRLINES HAVE IMPROVED OVER THE YEARS AND HOW THE SCHEDULED AIRLINES WILL CONTINUE TO ADD NEW AND FASTER AIRCRAFT TO INSURE IMPROVED SERVICE FOR THEIR CUSTOMERS.

Manufacturer	Model	1939	1949	1952	1956	1959	New aircraft on order for delivery in: 1960	1961
Boeing:	247D, 307B, 314	45	5	—	—	—	—	—
	377	—	35	44	34	21	—	—
	B707 (Jet)	—	—	—	—	66	20	1
	B720 (Jet)	—	—	—	—	—	24	25
Canadair:	CL44 (Turboprop)	—	—	—	—	—	—	17
Convair:	240	—	112	113	100	46	—	—
	340	—	—	8	123	122	—	—
	440	—	—	—	19	36	—	—
	540 (Turboprop)	—	—	—	—	1	10	—
	600 (Jet)	—	—	—	—	—	—	25[a]
	880 (Jet)	—	—	—	—	—	46	1
Curtiss:	C-46	—	2	75	94	66	—	—
Douglas:	DC-2	56	—	—	—	—	—	—
	DC-3	147	449	419	356	305	—	—
	DC-4	—	230	185	143	73	—	—
	DC-6	—	109	195	299	325	—	—
	DC-7	—	—	—	132	220	—	—
	DC-8 (Jet)	—	—	—	—	18	65	13
Fairchild:	F-27 (Turboprop)	—	—	—	—	34	7	—
Lockheed:	L-10	41	6	—	—	—	—	—
	Lodestar	—	11	11	10	—	—	—
	Other early models	6	—	—	—	—	—	—
	Constellation	—	79	115	117	104	—	—
	Super Constellation	—	—	24	79	137	—	—
	Electra (Turboprop)	—	—	—	—	96	34	—
Martin:	202	—	24	21	23	19	—	—
	404	—	—	96	97	85	—	—
Sikorsky:	All Types	28	—	—	—	—	—	—
Sud Aviation:	Caravelle (Jet)	—	—	—	—	—	—	20
Vickers:	V-700 (Series) (Turboprop)	—	—	—	54	67	—	—
	V-800 (Series) (Turboprop)	—	—	—	—	15	—	—
Other		24	10	17	25	15	—	—
Total Fixed Wing		347	1,072	1,323	1,705	1,871	206	102
Helicopters:								
Bell:	B47	—	6	6	7	5	—	—
Sikorsky:	S51	—	5	3	2	2	—	—
	S55	—	—	5	8	5	—	—
	S58	—	—	—	3	6	—	—
	S61 (Turbine)	—	—	—	—	—	—	11
	V44B	—	—	—	—	5	—	—
	V107 (Turbine)	—	—	—	—	—	—	10[b]
Total Helicopters		—	11	14	20	23	—	21

[a] Ten scheduled for delivery in 1961 and 15 in 1962.
[b] Five scheduled for delivery in 1961 and five in 1962.

COMPARATIVE TRANSPORT SAFETY RECORD

Passenger Fatality Rate per 100,000,000 Passenger Miles

(For Selected Years)

	1939	1949	1951	1952	1953	1954	1955	1956	1957	1958	1959
Domestic Scheduled Airlines [1]											
Fatalities	9	93	142	46	86	16	156	143	30	113	211
Rate	1.20	1.39	1.35	.37	.59	.10	.79	.64	.12	.45	.72
International and Overseas Scheduled Airlines [2]											
Fatalities	10	4	43	94	2	0	2	9	40	11	59
Rate	12.80	.19	1.59	2.98	.06	—	.04	.17	.67	.18	.86
Motor Buses											
Fatalities	[3]	130	140	120	100	60	90	80	90	120	n.a.
Rate	[3]	.23	.24	.21	.18	.11	.18	.16	.17	.24	n.a.
Railroad Passenger Trains											
Fatalities	32	29	150	14	50	23	19	57	17	62	10*
Rate	.14	.08	.43	.04	.16	.08	.07	.20	.07	.27	.05*
Passenger Autos and Taxis											
Fatalities	16,300	17,700	22,200	23,300	23,900	22,700	25,100	26,600	25,600	24,200	n.a.
Rate	3.7	2.7	3.0	3.0	2.9	2.7	2.7	2.7	2.6	2.3	n.a.

[1] Alaskan and Hawaiian data included in Domestic beginning in 1959.

[2] Alaska data not included in 1939.

[3] Motor Bus statistics included in Passenger Autos and Taxis.

* Preliminary

n.a. Not Available

POST OFFICE PROFIT ON DOMESTIC AIRMAIL

Fiscal Year	Post Office Receipts, Domestic Airmail Postage (000)	Payment to Airlines for Domestic Airmail Service [1] (000)	Other Post Office Expenses, Domestic Airmail [2] (000)	Post Office Profit on Domestic Airmail (000)
1950	$ 74,120	$63,639	$ 45,983	($35,502)
1955	142,571	42,780	79,524	20,267
1956	150,938	44,304	88,818	17,816
1957	153,189	45,913	91,607	15,669
1958	151,236	46,858	96,040	8,338
1959	173,379	50,000*	102,524*	21,455

[1] Payments to domestic and U. S.-Flag international airlines for hauling domestic airmail within continental United States and to off-shore states or territories. This is a Post Office allocation.

[2] Cost of postal services other than air transport of domestic airmail. Includes relatively small payments to surface carriers for hauling airmail and payments to airlines for hauling classes of mail other than airmail.

* Actual figures for 1959 not available. Figures shown are ATA estimates based on 1959 airmail traffic volume.

Source: U. S. Post Office Department, "Cost Ascertainment Report," for years shown.

CLASSES OF UNITED STATES COMMERCIAL AIR CARRIERS

There are nine generally recognized classes of operators in the air transport industry of the United States. These classifications are used by the Civil Aeronautics Board in connection with the economic regulation of the industry and under the Federal Aviation Act are based largely on the scope of operations authorized or allowed by that Act. Classes One to Seven have certificates of convenience and necessity authorizing them to conduct regularly scheduled services.

1. The Domestic Trunk Lines include those carriers which presently have permanent operating rights within the continental United States. There are currently twelve trunk lines, most of which operate high-density traffic routes between the principal traffic centers of the United States.

American	Continental	National	Trans World
Braniff	Delta	Northeast	United
Capital	Eastern	Northwest	Western

2. The Domestic Local Service Lines have, with one exception, been certificated since 1945. These carriers operate routes of lesser traffic density between the smaller traffic centers and between these centers and principal centers. The thirteen local service lines in 1959 were:

Allegheny	Lake Central	Ozark	Southern
Bonanza	Mohawk	Pacific	Trans Texas
Central	North Central	Piedmont	West Coast
Frontier			

3. The Intra-Hawaiian Carriers operate between the several islands comprising the State of Hawaii.

Aloha — Hawaiian

4. The Alaskan Carriers provide service among the continental United States and the State of Alaska and within Alaska.

Operating between continental U. S. and Alaska		Operating within Alaska	
Alaska	Pacific Northern	Alaska	Northern Consolidated
Northwest [1]	Pan American [1]	Alaska Coastal	Pacific Northern
		Bristol Bay [2, 3]	Reeve Aleutian
		Cordova	Western Alaska
		Ellis	Wien
		Howard J. Mays [3]	

5. The Helicopter Carriers presently operate between airports, central post offices, and suburbs of New York, Chicago and Los Angeles. Originally certificated as exclusive mail carriers they now fly passengers, airfreight and air express, in addition to U. S. mail.

Chicago Helicopter Airways — Los Angeles Airways — New York Airways

6. The International and Overseas Lines include all U. S.-Flag air carriers operating between the United States and foreign countries other than Canada, and over international waters. Some of these carriers conduct operations between foreign countries and some are extensions of domestic trunk lines into Mexico and the Caribbean and to Alaska and Hawaii.

Alaska [5]	Eastern	Pan American	Transportation Corp. of America
American	Mackey [2]	Pan American-Grace	Trans World
Braniff	National	Resort [2, 4]	United
Caribbean Atlantic	Northwest	Samoan [2, 5]	Western
Delta	Pacific Northern [5]	South Pacific [2]	

7. The All-Cargo Lines operate under temporary certificates authorizing scheduled cargo flights between designated areas in the U. S., and in one case to the Caribbean and in another to Europe.

AAXICO	Flying Tiger	Seaboard & Western
Aerovias Sud Americana	Riddle	Slick

8. Supplemental Air Carriers are authorized unlimited domestic charter operations and up to 10 flights per month individually ticketed or waybilled between any two domestic points. As of June 30, 1959, there were 23 carriers authorized for this service.

9. The Other classes of operators are the air taxi operators and airfreight forwarders. Air taxi operators are authorized through the exemption process and can operate aircraft up to a gross weight of 12,500 pounds. There are 2,370 authorized. Airfreight forwarders also operate under exemption authority. There are 72 forwarders operating in domestic interstate and foreign and overseas commerce.

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[1] Statistical data of these carriers are included with International and Overseas Airlines.
[2] Certificated non-mail carriers.
[3] Not operating.
[4] Certificated cruise carrier.
[5] Statistical data of these carriers are included with Alaskan Airlines.
[2, 5, 4] Statistical data of these carriers are not included in the statistical tables.

AIR TRANSPORT ASSOCIATION OF AMERICA

21ST EDITION

Facts and Figures, 1960

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Pan American-Grace Airways, *Andrew B. Shea, President, 135 East 42nd Street, New York 17, New York*
Pan American World Airways, *J. T. Trippe, President, 135 East 42nd Street, New York 17, New York*
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West Coast Airlines, *Nick Bez, President, Boeing Field, Seattle 8, Washington*
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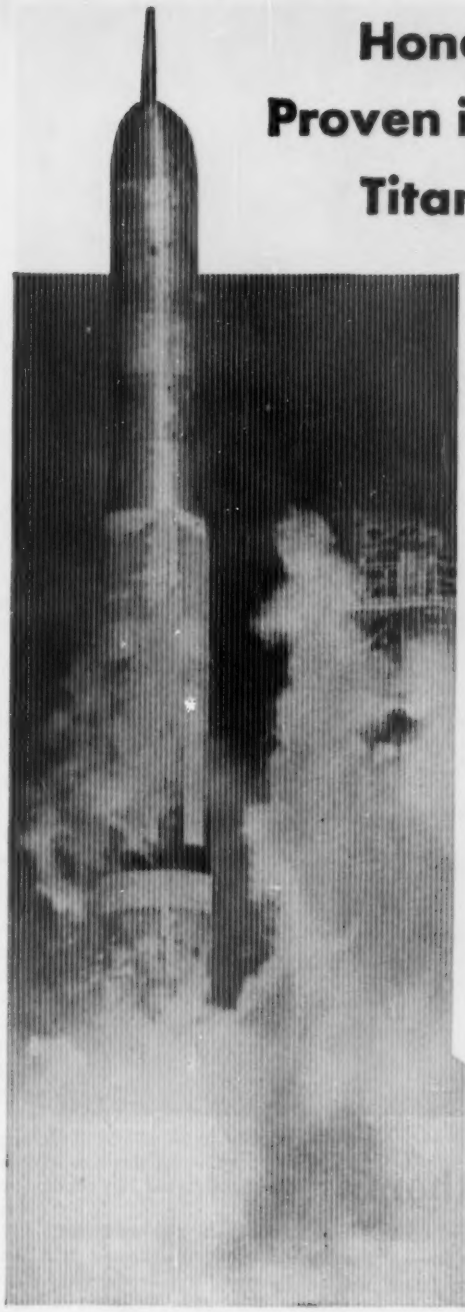
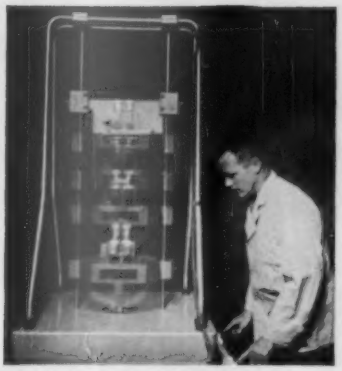
Honeywell Accelerometers Proven in Air Force Minuteman and Titan Tests





Honeywell accelerometers undergo a saw-tooth shock force of 100 G's for six milliseconds during test at the Environmental Test Laboratory of Avco's Research and Advanced Development Division.

Honeywell Linear Accelerometers, Model 515, were selected by Avco for the flight test instrumentation system of the Air Force TITAN and MINUTEMAN ICBM re-entry vehicles. The Avco Test Program included shock, random vibration, simulated transportation vibration, acoustic noise, standard acceleration, peak longitudinal and lateral acceleration, and high and low temperature tests. "Honeywell's Linear Accelerometers endured our Flight Proof Test Program without structural failure and were given our Flight Proof Test Certification" stated Mr. Paul Myslicki of Avco's Environmental Test Laboratory.

Type LA-500 series Linear Accelerometers are potentiometer output devices that feature constant damping and linear response. These reliable instruments are fluid damped and are designed to operate between −65°F and +175°F. Inherently insensitive to cross coupling accelerations, these non-pendulous instruments are provided with mechanical stops to prevent damage from input accelerations beyond the specified range. Write for Bulletin LA-500 to Minneapolis-Honeywell, Boston Division, Dept. 11, 40 Life Street, Boston 35, Mass.

Honeywell Linear Accelerometer Type 500, shown approx. ⅓ size

- Full Scale Range: ±1 to ±60 G
- Threshold: 0.02 G
- Potentiometer Resistance: 1,000 to 14,000 ohms
- Damping Ratio: 0.75 ±0.35 typical
- Natural Frequency: 5 to 19 cps
- Cross-axis Sensitivity: ½% of full scale
- Shock: to 50 G
- Vibration: MIL-E-5272
- Size: 1 7/16" diameter, 3¼" long
- Weight: 1 lb.

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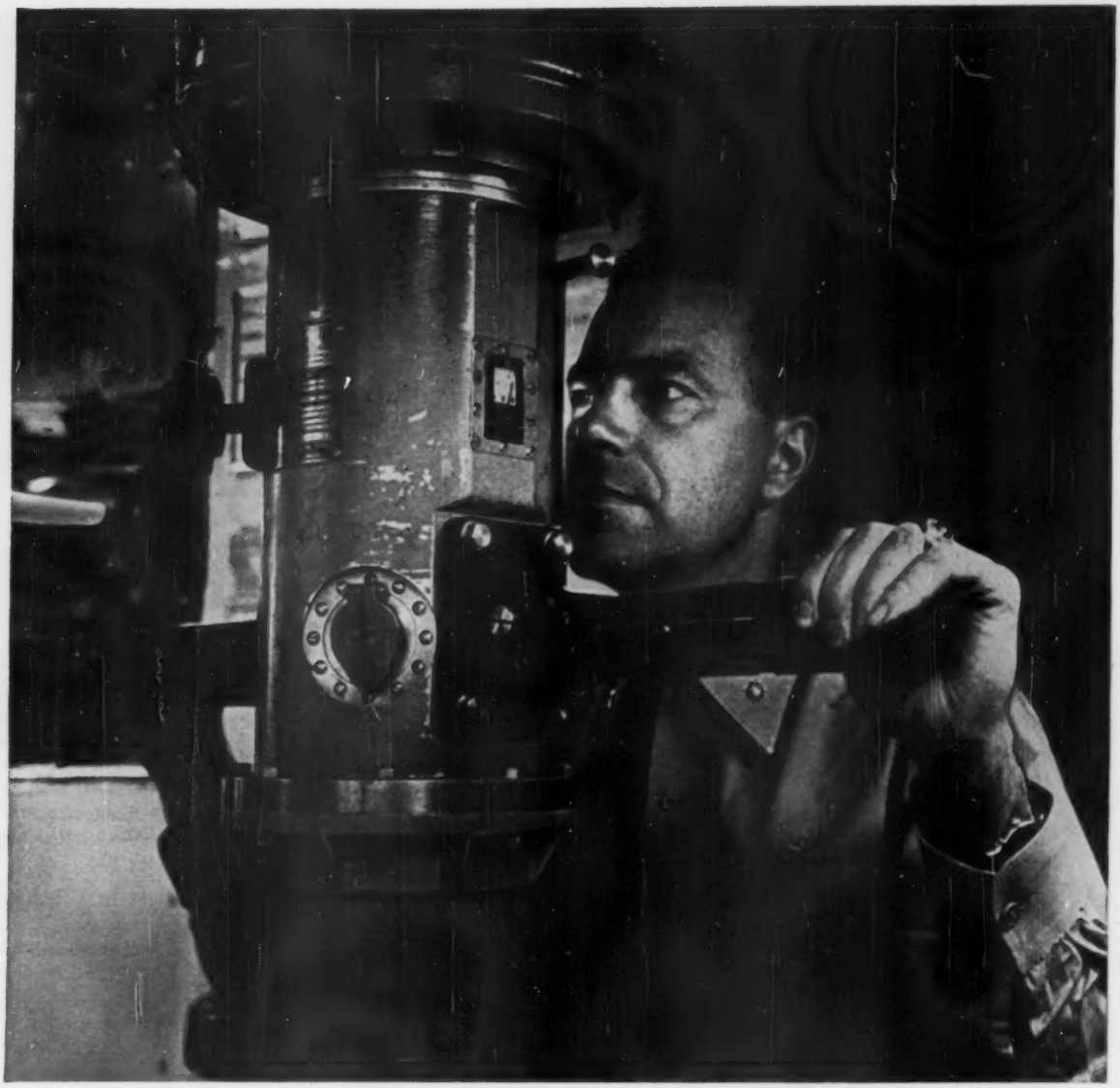

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Though new in concept, the Polaris program makes full use of the precision Shipboard Inertial Navigation Systems (SINS) developed and produced by Autonetics for the United States Navy.

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Advanced Autonetics' Shipboard Inertial Navigation Systems—like those to be used by the *USS George Washington*, the first Polaris-carrying submarine—will provide the critical missile alignment data to insure effective missile launching. SINS emits no tell-tale signals ... requires no receipt of external transmission at any time.

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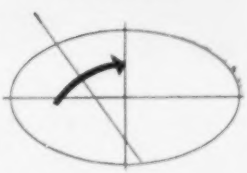

The flattening of the earth at the poles can result in a navigational error of almost eleven nautical miles if not taken into account.

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Caravelle Shows Service Dependability

By David A. Anderton

Paris—Low engine-failure rate coupled with relatively high daily utilization and minimum technical delays have characterized the initial period of Sud Caravelle twin-jet scheduled service with Air France and Scandinavian Airlines System.

Air France's chief engineer, André Péan reports a six months average of 0.37 engine failures per 1,000 hr. of engine operation. The airline's Caravelles got 6 hr. daily utilization on winter timetables with 7 hr. expected later this year, and had fewer technical delays than for any other airplane in the company's fleet.

SAS Engineering Vice President Knut Hagrup reports "almost negligible" flight remarks about the Rolls-Royce Avon Mk. 522 powerplants, daily utilizations of 7.5 hr., and predicts a delay rate below any other SAS transport.

Both airlines are showing 60 to 85% load factors on the internal European and Middle East runs with the Caravelle. Pilots, passengers and supporting personnel alike are enthusiastic.

Caravelle Operators

Air France and SAS between them have run up most of the in-service time on the Caravelle. As of Mar. 23, the French fleet of 11 planes had a total of 9,712 hr. time. SAS' 10-plane fleet had racked up 8,284 hr. Varig, which began Caravelle service toward the end of last year, has accumulated 1,165 hr. on two airplanes.

Air Algerie's flight time on the twin-jet transport totaled 548 hr., and Finnair, just starting service Apr. 1, had 148 hr. of route time on its planes.

Total time for all Caravelles in service totals 19,857 hr. as of Mar. 23, after less than one year from the date of the first scheduled Caravelle commercial service.

All Caravelles currently operational are of Mk. 1 configuration, using Rolls-Royce Avon Mk. 522 turbojets rated at 10,500 lb. sea-level static thrust each. But the first Mk. 3 Caravelle, with Rolls-Royce Avon Mk. 527 engines rated at 11,400 lb. thrust, was due to be delivered May 1 to Air France.

Remainder of Air France's Mk. 1 fleet will be converted—by engine changes only—to Mk. 3 configurations by next spring.

Deliveries of the Caravelle are continuing at about four per month, so that by the end of this year, Air France expects to be flying a total fleet of about two dozen Caravelles, most in the Mk. 3 configuration.

Caravelle Mk. 3 is the second step in Sud Aviation's development program for the plane, aimed at a continual improvement in both range and economy through minimum changes in the airplane and its systems. Change to the Mk. 3 is a simple one, and involves only replacing the engines.

Mk. 6 Caravelles, now on order by Sabena, also feature an engine change to the Avon Mk. 531, rated at 12,500 lb. takeoff thrust. But on this model, wheels and brake system will be changed to handle the increased gross weight. The stabilizer will be modified and some reinforcements will be made. Conversion price to make Mk. 6 airplanes from Mk. 3 models is about $70,000.

Final step currently envisioned is the Caravelle Mk. 7, powered by a pair of General Electric CJ-805-23 aft-fan engines.

This will not permit modification of the existing airframe, but will demand redesign of some parts. But the payoff is expected to be large. Compared with the Caravelle now in service, the Mk. 7 will have double the range, 50 kt. higher cruise speed, and a direct operating cost of less than two cents per seat-nautical mile.

SAS cost comparison between the Caravelle and Douglas DC-7C, both carrying 70 passengers on typical routes in Europe and the Middle East, shows that Caravelle variable operating costs per round trip and per seat-mile are 20 to 25% lower than DC-7C comparable costs. On a ton-mile basis, the cost differential shrinks to about 17%, because of the large freight capacity of the DC-7C.

Direct operating cost for the Caravelle, according to SAS figures, would be about 2.1 cents per seat-nautical mile, or about $1.47 per airplane-nautical mile.

The airline believes it possible to depreciate the Caravelle over a 10-year period instead of the current seven-year time allotted to piston-engine aircraft.

The SAS argument is that the modern design of the twin-jet transport keeps it competitive for a longer period of time. With airplane first costs being about the same for the Caravelle as for competitive piston-engine or turboprop-powered transports, annual depreciation works out greatly in favor of the Caravelle.

Direct Costs

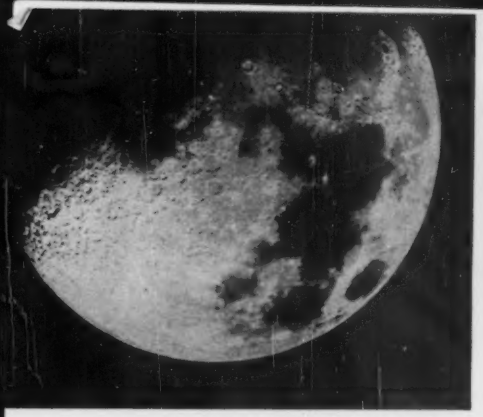
Using a 10-year depreciation for the French transport and writing the DC-7C off in seven years makes direct operating costs for the Caravelle about 30% lower.

Utilization of the Caravelles is considered high by both airlines, and averages about 7.5 hr. per day for the Scandinavian carrier and somewhat lower for the French. Air France says that it is difficult to fly a Caravelle as much as 3,000 hr. per year—not for technical but for timetable reasons. Night flights are rare; apparently the still-unsophisticated traveling European wants to move by daylight.

Timetable operations for the Caravelle were established by Air France in a conventional way, using route structure and average winds, and an added 15 min. per flight to take care of ground

Caravelle Development Program

Designation	Caravelle 1	Caravelle 3	Caravelle 6	Caravelle 7
Powerplants	R-R Avon Mk. 522	R-R Avon Mk. 527	R-R Avon Mk. 531	Gen'l. Elec. CJ-805-23
Thrust, lb., per engine	10,500	11,700	12,500	16,100
Max. takeoff weight, lb.	95,900	99,210	103,620	110,230
Landing wt., lb.	91,340	94,470	98,655	104,720
Zero-fuel wt., lb.	77,160	77,660	78,265	79,365
Oper. wt. empty, lb.	57,760	57,950	.....	60,620
Useful load, lb.	19,400	19,700	18,965	18,745
V_{mo}	300	300	320	350
M_{mo}	.75	.75	.77	.77
Runway length for takeoff, ft.	5,900	6,200	6,100	6,000
Range, naut. mi., with zero wind, full payload, normal fuel reserves	900	1,110	1,350	1,970
Delivery year	1959	1960	1961	1963



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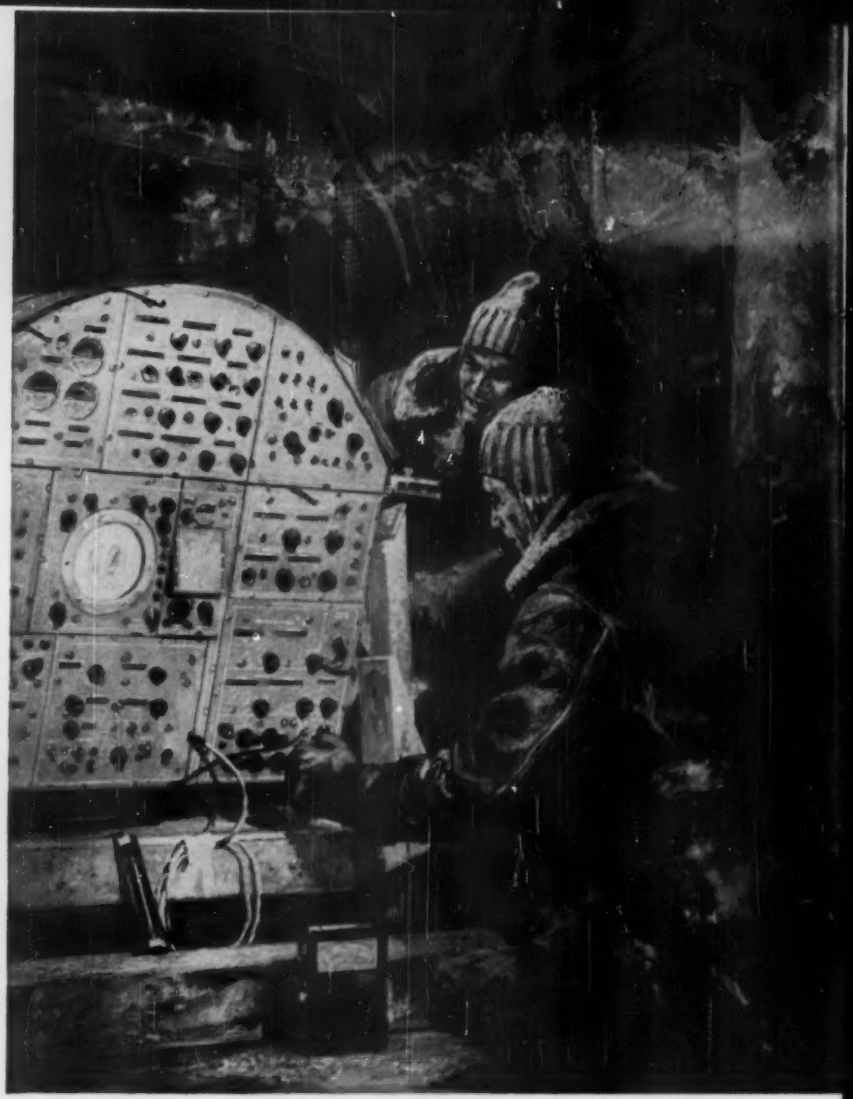

ENVIRONMENTAL CHECK FOR HUSTLER BOMB-NAVIGATION SYSTEM. The USAF's supersonic bomber must maintain global capability over a period of years. Here Sperry engineers put the control console of the B-58's rugged, highly accurate bomb-nav system through its paces.

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Air Armament has produced or is developing advanced air and space craft equipment such as inertial navigation components for space-exploring vehicles . . . USAF's lightest and smallest search radar . . . Loran C radio navigation system that can pinpoint position up to 1500 miles. And when North American's X-15 takes the first man to the fringes of space and back, an advanced Sperry inertial system will guide him.

Meanwhile, Sperry continues to research and develop still more advanced concepts for ever sharper "shots" in space. Air Armament Division, Sperry Gyroscope Company, Division of Sperry Rand Corporation, Great Neck, N. Y.

SPERRY

time and delays. Measured averages for Air France run about two minutes for starting, seven minutes from start to takeoff, and between 12 and 15 min. for landing procedure and run-in.

Ground time at an airport is determined by the delays in handling passengers rather than the airplane. Including refueling, both Air France and SAS figure 20 min. is enough, but to move passengers out to the airplane means increasing the time to half an hour. SAS complains that some airport authorities don't accept the Caravelle as just another airplane, and as a consequence, the airline has to park at the far end of the terminal building. Then the passengers have a long walk or bus ride to the plane, and that produces further delay on the ground.

Standard Plan

Simplified flight plans are used by both airlines in Caravelle operations. SAS uses one standard plan for its short Europoean routes which is modified at the last minute to account for actual weather. Air France uses separate flight plans for each trip rather than a modified standard for all, but has carefully studied procedures to make planning time a minimum. Flight plans for the next leg can be prepared during a trip.

Air France calculates its fuel reserves needed for a flight by establishing a 5% route reserve, plus 440 lb. special reserve, plus 880 lb. allotted for letdown procedure from the beacon to wheels on the runway. The alternate reserve is calculated by allowing 1,540 lb.–20 min. time–for holding at 5,000 ft. plus a variable amount between 440 and 1,980 lb., depending on conditions of flight.

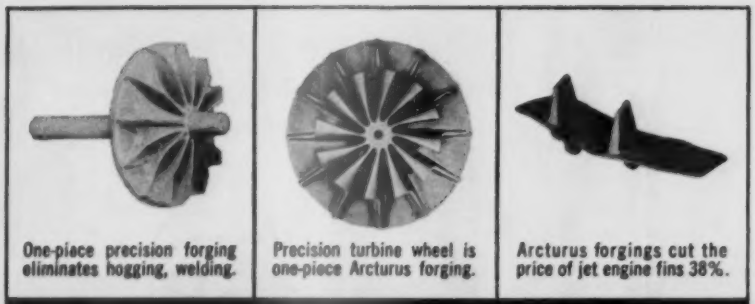
Wind forecasting could stand some improvement, says Air France, so that fuel and reserves could be calculated more precisely.

Flight Training

Both airlines report low transition times for crew members making the change to Caravelles. Air France says the pilot needs about 12 hr. in the cockpit, the copilot 10 hr., and the engineer eight hours for thorough training on the airplane, its flying and operating characteristics.

SAS gives its captains and copilots about 15 hr. time in the airplane.

Technical and ground course offered by the Scandinavian carrier lasts five weeks, and covers theory of jet engines and jet aircraft performance. The company divides its flying training into two phases. In the first, captains and copilots spend three sessions flying the airplane and three sessions observing others flying the airplane. After this, they go to the second phase–three sessions of route exercises–and go



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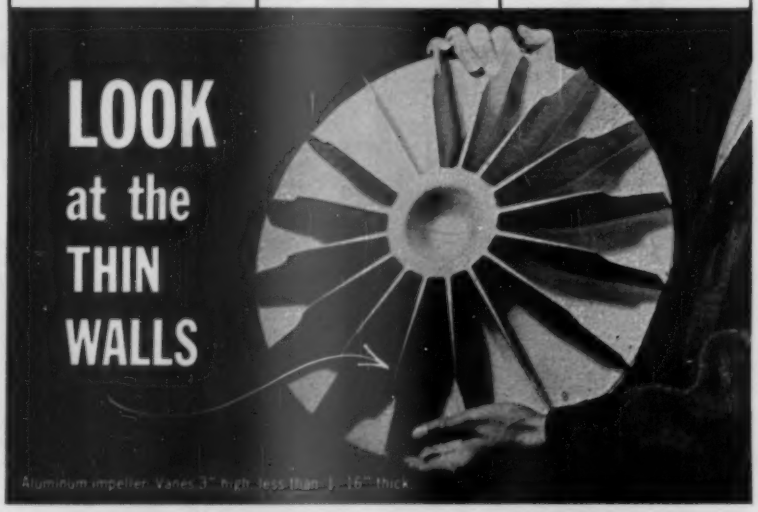

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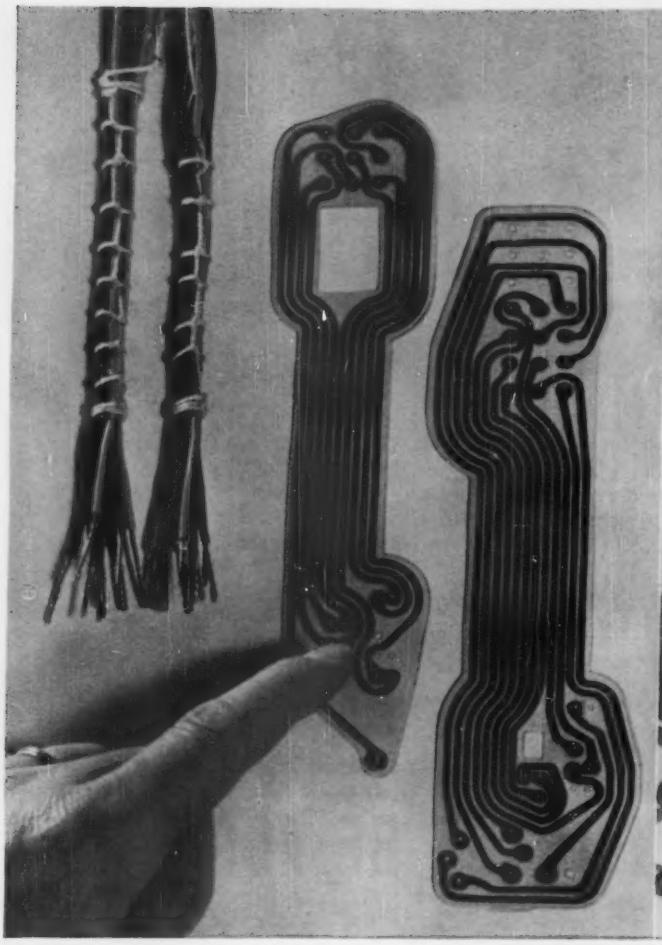

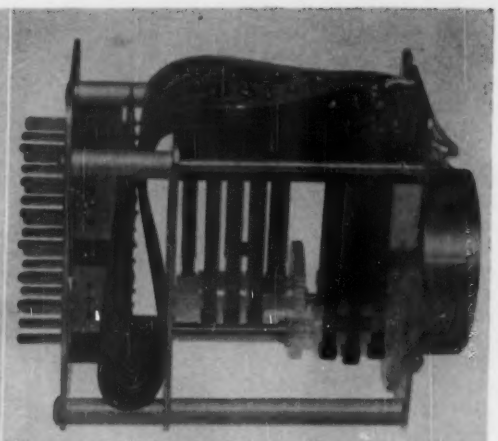

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Fleet Malfunctions and Technical Delays

Scandinavian Airlines System

Type aircraft	Flight time hours per month	Number takeoffs per month	Flight time per takeoff	Number malfunctions per 1,000 takeoffs	Number technical delays (more than 30 min. per 1,000 takeoffs)
CV-440	3,850	3,840	1.00	340	9
DC-6	1,356	1,018	1.33	540	16
DC-6B	4,330	1,239	3.50	940	38
DC-7C	5,632	1,017	5.55	1,540	77
Average	3,792	1,779	2.85	850	35
Caravelle	856	639	1.34	700	47

Source: SAS Engineering Department; Data for first six months' operation of Caravelle.

through normal and emergency procedures, flight planning, and en-route changes of plan due to simulated engine failures and decompression.

Total flight time during this course is about 15 hr. for the SAS crews. The Caravelle captain then starts a 50-hr. period of route training, flying as copilot in a Caravelle. The copilot trainee flies as third pilot during this phase.

Both airlines are exteremely enthusiastic about the way the Caravelle handles in the air. "It's the best airplane in the fleet on flying characteristics," said Paul Besson, in charge of Air France's flight operation at Paris' Orly Airport. "It has the landing speed of a DC-4, but is more responsive on all axes."

"Pilot reaction has been extremely favorable," said Hagrup of SAS.

No Control Problems

Pilots say they can forget they have a powerplant, and there are no engine-out problems. They report no control problems, either, and like the speed brakes because of the way they help the Caravelle fit into existing traffic patterns.

Air France has been monitoring takeoffs by using airspeed in the conventional manner, but the use of the IIS (integrated instrument service) system to control the pitch angle of the aircraft has given better information during takeoff than the airspeed indicator only.

SAS monitors takeoff by timing acceleration to 90 kt. and says that such a procedure is ". . . very exact."

SAS comments favorably on the visibility from the cockpit windows during climbout. Air France says that view from the windows could be improved, and there is a mockup of a new cockpit window arrangement for the Caravelle which may be adopted later.

Both airlines are pleased with the Lear autopilot and automatic approach system. Says SAS: "Provided the ground ILS installation is good, the autopilot will fly an ILS approach better than most pilots could hope to do themselves." Air Force technicians, who at first opposed the installation of the Lear system, have swung completely around now and are among its most enthusiastic boosters.

Approach speed for the Caravelle is about that of the SAS DC-6B and DC-7C, so that the pilots have no problem in getting used to a hotter pattern speed. SAS pilots dump full flaps at the outer marker, though, and maintain minimum final approach speed all the way in. This way they get a low approach speed, but it requires some extra precision in flying the airplane.

Anti-skid brake system of the Caravelle is liked by the pilots. SAS also says the brake chute used on wet or icy runways has been most effective,

First Trans-Canada Vanguard Nears Completion

First of 20 Vickers Vanguard 952 turboprop transports ordered by Trans-Canada Air Lines nears completion in Vickers' new preflight hangar at Weybridge, England.

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and has produced no unfavorable passenger reaction. It feels like hard wheel braking.

Air France engineers believe the flaps of the Caravelle could be improved somewhat. The low ground clearance of the wing precludes extension of the flap chord much further, and any improvement in the flap system would probably mean dropping the ailerons as well.

No special instrumentation has been necessary for the Caravelle. Engine rpm. is measured by a precision Jaeger tachometer which gives a reading accurate to plus or minus 5 rpm., but otherwise instrumentation is standard.

Air France results with the Kollsman precision altimeter indicate an accuracy of plus or minus 200 ft.

Few Malfunctions

Air France says the Caravelle has fewer technical delays than any other airplane in the company's fleet. SAS shows a figure of 47 technical delays of more than 30 min. duration per 1,000 Caravelle takeoffs. This is more than the 35-delays average of the company's piston-engine fleet, but considerably less than its newest DC-7Cs, which average 77 delays per 1,000 takeoffs.

SAS statistics show about 700 malfunctions of all types per 1,000 takeoffs of the Caravelle, which is lower than the average of the piston-engine fleet by a substantial margin, and less than half of the DC-7C figure.

But the airline points out that its Caravelles were production planes right off the front of the production line, numbers 3, 5, 6 and 8 respectively for the first four planes in service, on which these statistics have been based. In contrast, its first DC-6 was number 106 on the line, and each DC-6 in the fleet has about 20,000 hr. minimum flight time. SAS' first DC-7C was number 695 in the DC-6/-6B/-7C series, and each DC-7C now in the fleet has more than 7,000 hr.

The Scandinavian carrier is confident that the Caravelle will improve so that both malfunctions and delays will be better than for any aircraft in their present fleet.

Caravelle Modifications

Modifications on the Caravelle are currently low, totaling only about 200. This number compares to about 3,000

Caravelle Orders and Deliveries

May 1, 1960

Customer	Firm Order	Options	Delivered
Air France	24	....	12
SAS	18	8	12
Varig	2	....	2
Finnair	3	....	3
Air Algerie	4	1	3
Royal Air Maroc	2	....	1
Alitalia	4	4	2
Sabena	4	4	0
General Electric Co.	1	....	0
United Airlines	20	20	0
Total	82	37	35

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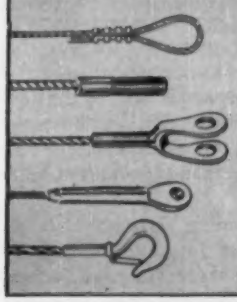

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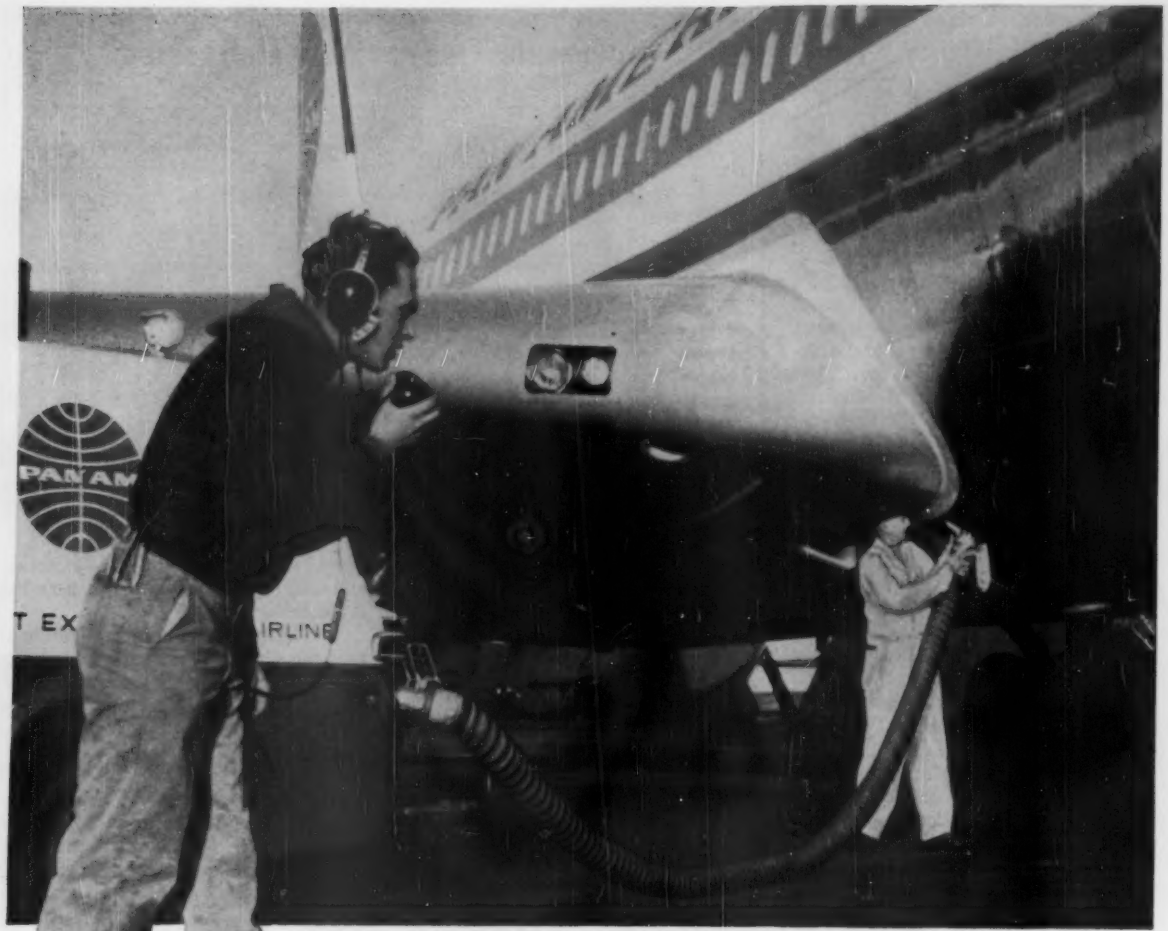

"Our previous hose gave out after only 1200 to 1400 starts . . .

Thermoid-Quaker Jet-Starter Hose good as new after 3,500 starts"

says Mr. B. V. Darress, Maint. Supr. Pan American World Airways.

Jet-starter hose has to take unusual abuse: transmit hot air up to 500°F at up to 600 MPH under sub-zero conditions . . . withstand dragging over abrasive surfaces. Yet it must be light-weight and flexible . . . easy to handle and coil on the starter truck for storage—and it can't kink, collapse or burst.

Thermoid-Quaker Jet-Starter Hose meets these "impossible" specifications and has proved it can take this kind of abuse with Pan American World Airways and the U. S. Air Force. According to Mr. B. V. Darress of PanAm, their previous hose became unserviceable after only 1200 to 1400 starts. Thermoid-Quaker hose has already outlasted the former hose by *three* to *one* and still looks like new!

Economical service like this is extremely important to both commercial and military jet operations. In fact, this Thermoid-Quaker "Dacron" and Silicone rubber jet-starter hose was developed for military use, and is used by the government. "Dacron" cross-braid construction distributes the load evenly, prevents kinking; and the seamless silicone rubber tube and bonding layer resist heat and provide flexibility under low temperatures.

Get complete information, including Technical Data, on Thermoid-Quaker Jet-Starter Hose from your Thermoid Division industrial distributor, or write *Thermoid Division, H. K. Porter Company, Inc., 200 Whitehead Road, Trenton 6, New Jersey.*

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Airline Passenger Terminals Under Construction at Idlewild

New multi-million-dollar individual passenger terminals of airlines serving New York International Airport are shown under construction. Pan American World Airways building is (1) above; American Airlines, (2); United Air Lines, (3); and Eastern Air Lines, (4); American, United and Eastern terminals are now in operation. Construction of additional terminals will take place this year. At center of picture is International Arrivals Building and adjacent Wing Buildings where foreign-flag carriers operate their passenger services.

for the DC-6 and DC-6B fleet, more than 1,000 for the DC-7C fleet, and about 1,000 on the Metropolitans.

Performance of the Rolls-Royce Avon engines has been remarkable, according to both operators. Flight remarks have been almost negligible, said Hagrup.

In Air France's early experience, based on four Caravelles in service, they were getting 0.7 jet engine failures per 1,000 hr. of operation, resulting in a delay of 1.67 hr. per 1,000 hr. and no engine changes away from the main overhaul base. This compared with a figure of 2.9 failures per 1,000 hr. for its best piston-engine, and delays of 43.1 hr. per 1,000 hr.

Recent Figures

Most recent figures from the French carrier shows even further improvement, almost having the failures. On Mar. 1 this year, after 8,299 hr. of Caravelle flight time, Air France had an average engine failure rate of 0.37 per 1,000 hr. of operation.

Both companies report minor problems with cracks in non-primary structure, such as flaps, rudders and elevators. They have been concentrated in small areas, says SAS, but definitely not in load-carrying portions. Reinforcements have been designed by Sud Aviation or by the airlines, and modifications in the structure have been made.

Engine Starting

Starting the Caravelle engines is done by batteries in the airplane, to avoid supplying a 115-v.d.c. cart to every station en route. Normal use of the batteries produces about six starts befor recharging is necessary, and a minimum of three starts is possible.

Electrical systems are working well, reports Air France. The company's planes are equipped with d.c. systems, using Bendix generators. But the increase in electrical power requirements makes the available power marginal.

SAS has installed a.c. systems, in contrast. The airline makes no comments about its problems, one way or the other.

Other Systems

There probably never has been an airplane without hydraulic system troubles, and the Caravelle was no exception. It started life with some problems, primarily cracked tubes, but these have since been solved by replacing the aluminum-alloy tubes with steel ones. SAS reported some failures of the pressure-regulator springs, and said that further planned modifications in the system should solve the last remnants of trouble.

Brake wear has been heavy in the initial period, but that was attributed to a tendency by pilots to overbrake, a common routine with any new airplane. As pilots have gotten familiar with the brakes, the wear has been reduced markedly.

Improved brakes will be added to the Caravelle on the Mk. 6, and should im-

THE STATS ARE IN

RAVEN MOST VALUABLE PERFORMER

Leading in all departments in the light helicopter league is the Army H-23D Raven — the latest in a helicopter line noted for its seemingly endless growth potential. Here are highlights from an impressive array of statistics on the D Model Raven from Camp Wolters, Texas, U. S. Army Primary Helicopter School, and the world's largest helicopter operation.

Total flight hours training per month	7,000
Number of Aircraft	130
Availability, Including All Maintenance And Overhaul	85%
No. Autorotation (Practice Power Off) Landings per School Day	1,000
Overhaul Life (Major, all components)	1,000 Hrs.
Maintenance Hours, Ravens vs. all Army Average	less than 50%

One figure is missing from our collection... because it is inestimable. That's the value of the investment in dynamic components with designed-in future. They're ready now to drive entirely new craft of even greater economy and versatility.

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prove service life considerably. Both airlines are pleased with the anti-skid feature of the Caravelle brakes, and SAS considers such brakes mandatory for all passenger-carrying jet aircraft.

Air conditioning and de-icing system has given some trouble, particularly in the automatic controls. Some of the hot-air tubes have cracked, and the cockpit de-icing has been criticized by pilots. But these troubles are reported completely under control.

Gear Failures

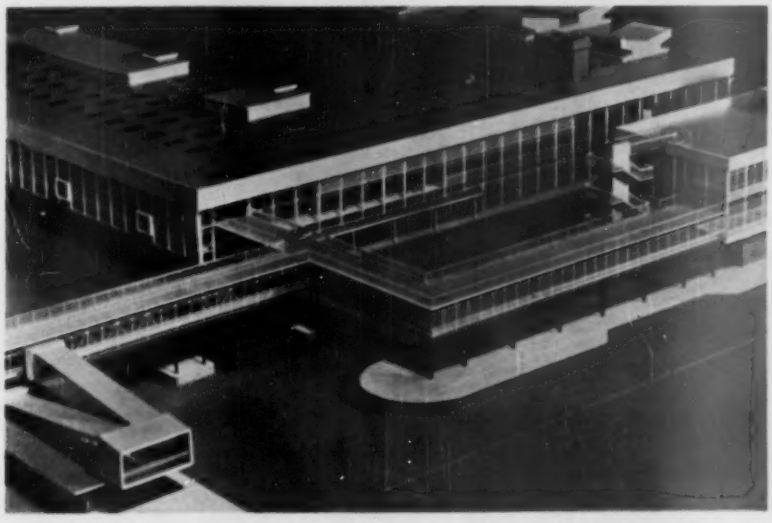
Landing gear and door indicators have sometimes failed to work, because of microswitch failures, but these are being modified, SAS says.

SAS points out that the fuel flow and quantity measuring system has not worked to its entire satisfaction. The problem is not the few and minor technical troubles, but rather the accuracy. System accuracy is a big improvement over the installations for piston-engine airplanes, but it is not good enough for jet aircraft.

Radio Equipment

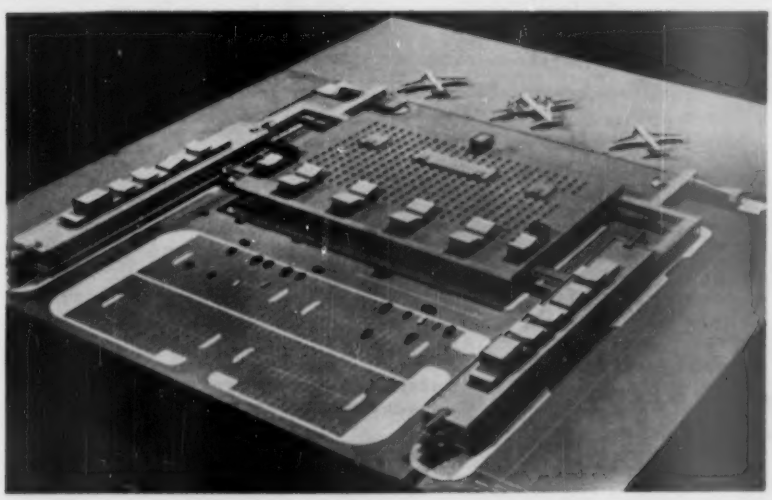
Radio equipment, generally identical to that used in SAS' DC-7C fleet, is reliable, the airline says. They do have a strange problem with interference, caused by passenger use of portable transistor radios. The company hopes that the problem will be solved by improvements in the portable units, because it seems impossible to keep passengers from carrying them on board.

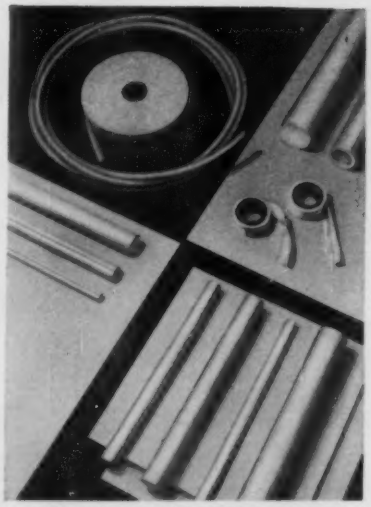
Air France technical experts say there



New Passenger Facilities at London Airport

Model of the new $8.4 million passenger complex now under construction at London Airport shows bridges and ramps leading to the aircraft stands (above) and over-all view of the facilities (below). All administration facilities and the main restaurant are located in the three-story office blocks which flank the passenger building. Facilities are expected to become operational by the end of 1962.





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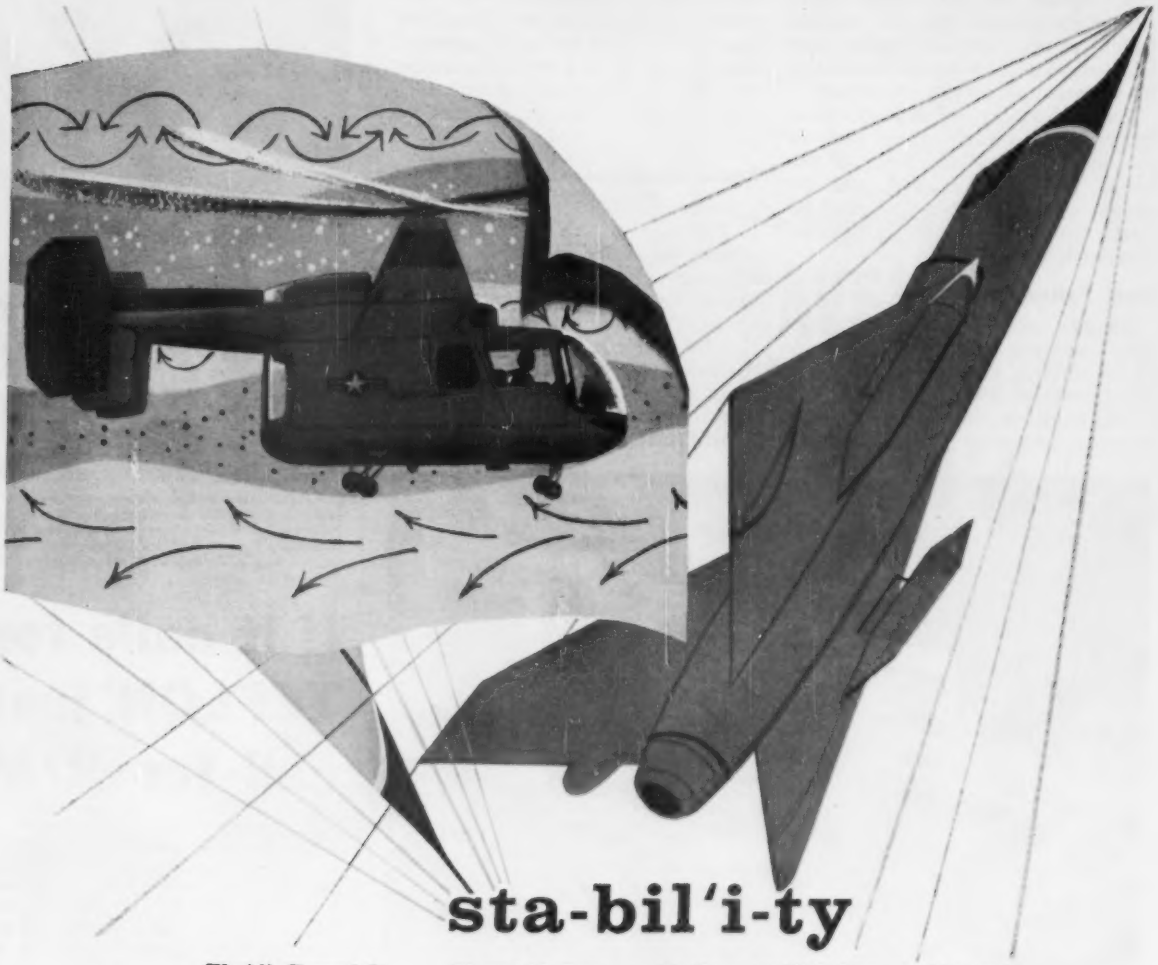

sta-bil'i-ty

World's Record #1 — *Bloomfield, Conn. — Air Force established new world record by flying the H43-B Huskie turbine helicopter to 30,100 ft.*

World's Record #2 — *Edwards AFB, Calif. — Air Force established new world record by flying the F-106 over an 18 km course twice, averaging 1,525.9 mph.*

Stability augmentation from Nortronics steadies both of these record-setting vehicles. In missiles — the Navy Terrier and Tartar, the Army Nike-Zeus; and in submarines — the Polaris class, Nortronics, Precision Products Department supplies gyros fundamental to accurate positioning and control.

The Precision Products Department (formerly American-Standard, Military Products Division) is responsible for the Polaris Type 11 Periscope System for navigating submerged, and the submarine Radiometric Sextant for "shooting the sun" in poor visibility.

Opportunities for Engineers

Winning this degree of acceptance has created new career opportunities in advanced design, production and applications engineering. Nortronics, Precision Products Department, Norwood, Massachusetts.

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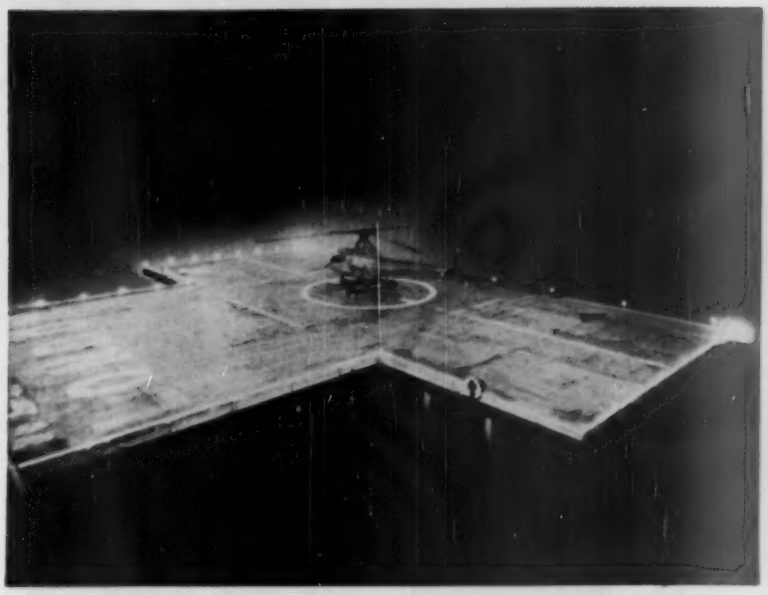

Lights Installed at London Heliport

Westland Aircraft's London heliport has been equipped by General Electric Co., Ltd., with lights for night operations (AW Apr. 6, p. 44). Westland Widgeon lands on pad on Thames River. Colored signal lights indicate if approach is correct, too high or too low.

is no pattern to their minor technical problems, and they apparently are completely random.

Perhaps the best last word on the Caravelle comes from SAS' Hagrup. "Frankly, we have been looking for some disadvantages during our operations with the Caravelle and its rear-engine mounting. There have been a large number of inquiries from airlines all over the world on this subject, with a variety of suggested disadvantages.

" . . .We expected to encounter some weight and balance problems when we put the aircraft into scheduled service. We were especially concerned with the probable need for certain restrictions in passenger seating. We have had to impose no such restrictions, and we have not run into any weight and balance problems. The center of gravity behaves just as perfectly in the Caravelle as in the best piston-engined aircraft today.

"We have been unable to detect any disadvantages."

Subsidy Bid Rejection Proposed

Washington—Civil Aeronautics Board attorneys have rejected bids for subsidy eligibility filed more than a year ago by Slick, Riddle, AAXICO and Flying Tiger Line in the Domestic Cargo-Mail Service Case.

At the same time the attorneys recommended that all of the cargo carriers except AAXICO, which suspended common carriage operations last year, should be granted permanent operating authority over their present route systems with the proviso that the airlines offer regularly scheduled service. AAXICO's operating certificate should not be renewed, they said.

Speaking for CAB's Bureau of Air Operations, the attorney's recommendations were released in a tentative statement of position. Reasons behind the recommendations will be detailed in a brief being prepared for presentation to a hearing examiner on May 26.

Remaining portions of the bureau's statement recommended that the airlines be permitted to conduct all-cargo service to and from domestic military installations on a flag stop basis in connection with their scheduled route operations.

Such service would be provided wherever the military bases are located near the airline's cities of origin and destination.

Both combination and all-cargo airlines, the attorneys said, also should be allowed to provide flag stop service on scheduled all-cargo flights to off-route shippers who may have sufficient volumes of cargo to warrant the service under individual temporary exemptions granted by CAB.

The bureau took a similar stand on the airlines' request to have truck points designated on their certificates and recommended that such truck-air service be provided on an individual temporary exemption basis.

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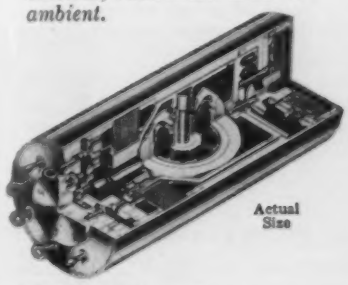

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WOODEN MOCKUP of the Vickers VC.10 at Weybridge, England. First of the turbojet transports will fly in fall of 1961.

VC.10 to Use Split System for Control

By John Tunstall

Weybridge, England—Vickers VC.10 four-turbojet transport, now under construction at Vickers-Armstrongs' plant here, will utilize an all-powered-control system, split between hydraulic and electrical systems.

The hydraulic system will power the variable incidence tail plane and the spoilers, and the electrical system will operate the elevators and ailerons. Systems will operate as a duplex unit, but in the event of failure of one system, the other is capable of maintaining lateral and pitch control.

Each system, Vickers said, is duplicated and contains its own emergency ram air turbine. The company currently is building a $750,000 full-scale systems test rig to prove out the power controls and autopilots.

Three VC.10 Versions

Project work on three VC.10 versions —a swing-nose freighter (AW Feb. 15, p. 50), a Super VC.10 with a 30-ft. extension in nose and center sections, and the VC.11 medium range version—has been completed. British Overseas Airways Corp. currently is negotiating for a reported 10 Super VC.10s. The airline has ordered 35 VC.10s powered by Rolls-Royce Conway rear-mounted bypass engines, and holds options on 20 more (AW Sept. 21, 1959, p. 38).

Vickers is completing the first of three VC.10s which will be used in the certification program; first flight is scheduled for the fall of 1961. Maximum cruise speed will be Mach .86.

Control layout is based on a combination of electro-hydraulic and duplex hydraulic power systems in conjunction with sectionalized control surfaces. Total failure of both systems is countered by two ram air turbines, one driving an alternator which energizes an emergency bus bar; the other drives a turboprop. This unit can power four of the six spoilers, the tailplane, slats and flaps. In the duplex autopilot installation, each autopilot commands an independent master control unit in each control axis. The Bendix autopilot is made under license by Elliott.

On an emergency approach, the ram turbopump would be switched to the spoilers and tailplane.

The ailerons and elevators are each divided into four sections and the rudder into three, making a total of 11 control surfaces, each powered by its own independent electro-hydraulic power unit which acts directly on the respective surface. The packaged units are of Boulton Paul Aircraft, Ltd., design and are adapted versions of equipment fitted in Britain's V-bombers.

Any three units in either of these control axes can neutralize a fully deflected runaway section without change of aircraft attitude until the malfunctioning section is switched off by the pilot. It will then trail, heavily damped, to a minimum load position and then automatically lock mechanically against flutter and gust loading. Vickers maintains the aircraft can be flown safely with only one section operative. A collapsible spring strut in the linkage to each surface allows the common linkage to operate the remaining surfaces unhindered.

Control Linkage

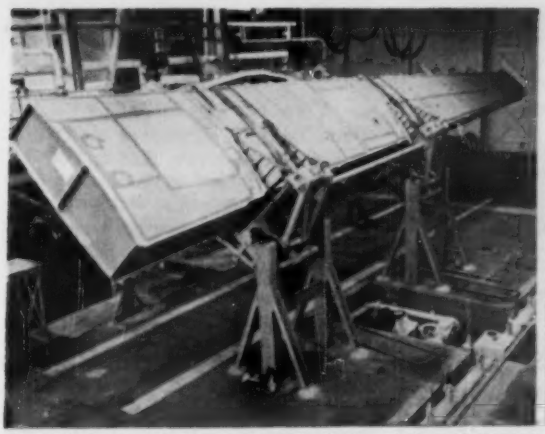
The elevator and rudder control systems are fully duplicated. The elevator linkages from one pilot's control column operate on the control valves of the outer elevators and those from the other pilot's column operate on the inner pair, the system being duplex and coupled at the flight deck and the rear of the cable system.

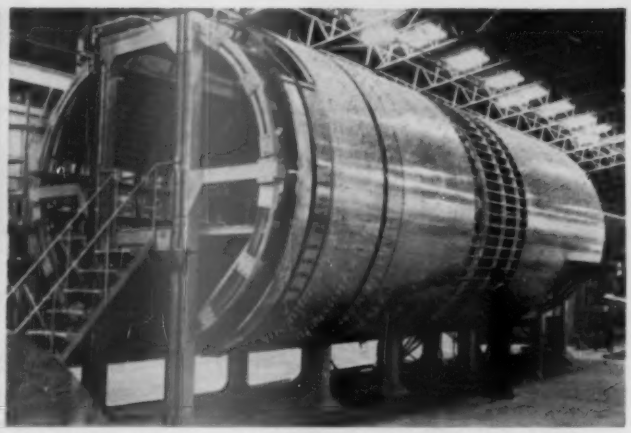
Only a small part of the control linkages are subject to heavy loads—that section running from the pilots' control columns to the "feel" simulator unit placed behind the cockpit. Rods and levers are used where the circuit geometry becomes complex but very large sections are severed by flexible cables suitably tensioned. Both manual and autopilot input signals are processed by the unit.

Also duplicated are the normal and automatic trimming systems of the hydraulic-operated variable incidence tailplane.

The hydraulic system itself is dupli-

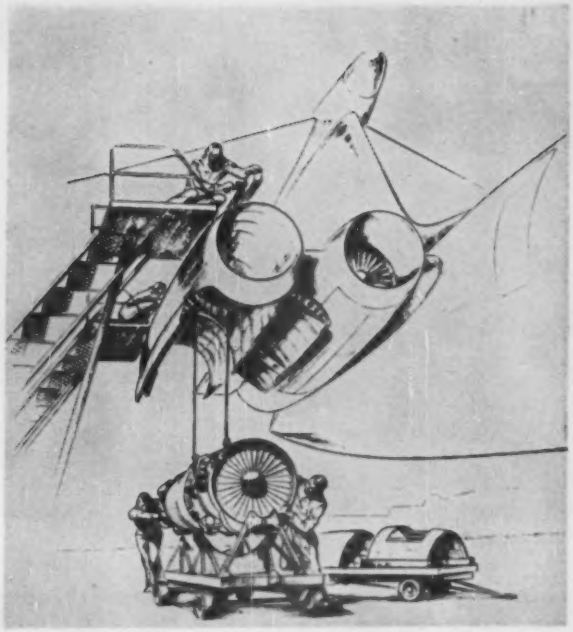
BRITAIN'S largest universal milling machine works on a 40-ft. integral wing panel at Vickers-Armstrongs' Weybridge plant.



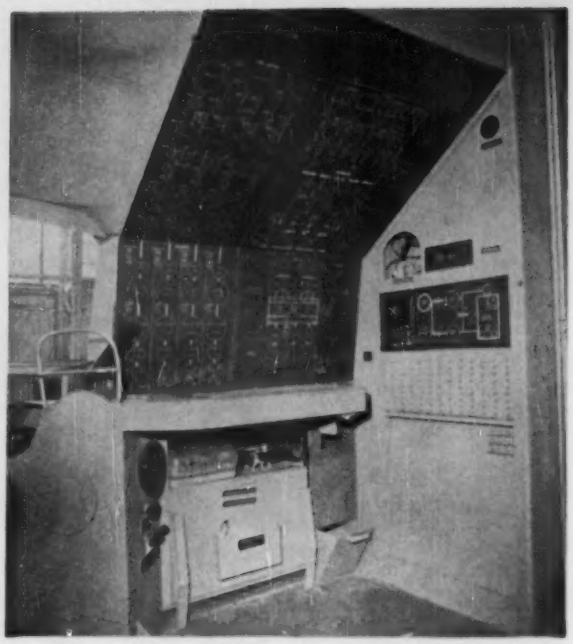


VANGUARD torsion box sealing rig (left) will be scaled up for the VC.10. The box is half-filled with sealer and rotated. Almost the whole wing torsion box of the VC.10, including webs and inboard ribs, is machined, as is more than 50% of the airframe structure. At right, center fuselage section of the first VC.10 is under construction. Three VC.10s will be used for certification.

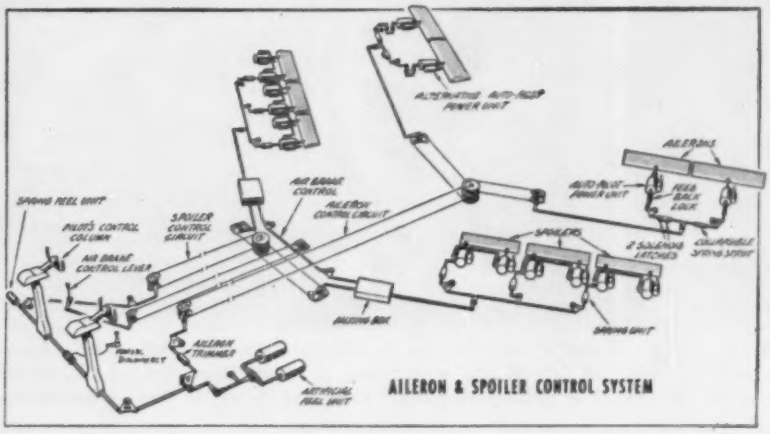
TORSION BOX test specimen is shown at Vickers' Weybridge plant. The VC.10 wing is of four- and three-web- construction with closely spaced integral ribs. Integral wing skin-stringer panels are milled from slabs 23 ft. 6 in. x 2 ft. 6 in. x 3 in. thick.



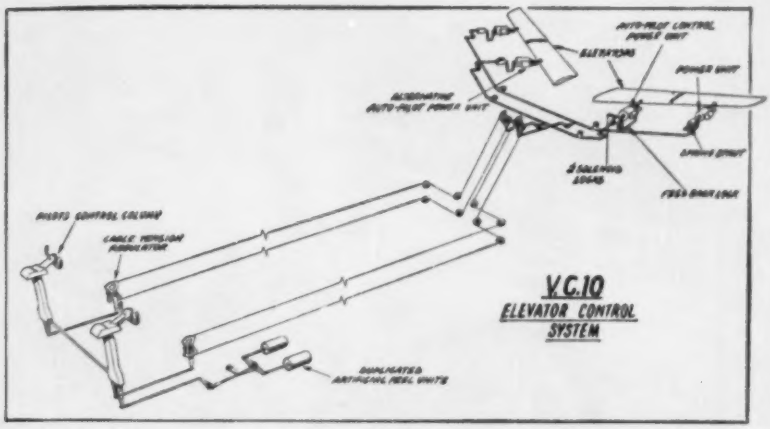
METHOD of changing an engine on the VC.10 is shown in drawing.



Mockup at right shows flight engineer's position in the VC.10.



AT CRUISE the ailerons and spoilers share the lateral control load equally. Spoiler mixing boxes combine simultaneous lateral control and airbrake input demands.



ELEVATOR linkages from one pilot's control column operate on the control valves of the outer elevators and those from the other pilot's column operate on the inner pair.

cated; the two motors driving the tailplane transmit through a differential and irreversible worm gearing.

Ailerons and spoilers are functionally dependent, the control linkage for the spoilers being hydraulically operated from one pilot's column and the linkage to the electrically-operated ailerons being connected to the other side of the shafting. At cruise, ailerons and spoilers share the lateral control load equally.

Spoilers also double as air brakes and simultaneous lateral control and airbrake input demands are summed in a mixing box in each wing. Each of the spoiler sections has two jacks with the control valves coupled in pairs.

Production Details

More than 50% of the airframe structure is machined. Machined parts include virtually the entire wing torsion box including the webs and inboard ribs, the fuselage side panels in the center section of the wing, and the window panels elsewhere along the fuselage.

The wing is of four- and three-web construction with closely spaced integral ribs. Integral wing skin-stringer panels are milled from slabs 23 ft. 6 in. x 2 ft. 6 in. x 3 in. thick. Chord curvature is imposed by shot peening. The wing is made in five sections and provides integral tankage from tip to tip. Inspection panels, Vickers emphasizes, are in the upper compression wing skin.

Outstanding production items are the center fuselage panels (minimum thickness 12 gage) machined integrally from slabs 34 ft. 6 in. x 6 ft. x ¾ in. thick. Each panel includes two escape hatches and four windows. Decision to

machine the panels rather than employ chemical milling techniques stems from Vickers' need to exploit its machine capacity and know-how established with the Vanguard.

A considerable amount of stainless steel is used in the VC.10 airframe but no titanium is used outside the engine bays. Laminated reduxed sandwich construction is used on control surfaces mainly for matching reasons, and in chassis doors and some floor panels. But in other areas, notably in the empennage, the construction is used to resist noise fatigue damage.

Major stainless steel members include the engine cantilevers, front and rear, each linked across the fuselage by steel beams and from which the engines are suspended in pairs; fuselage frames at the wing/fuselage junction; main landing gear struts and the transverse member of the chassis structure. The steel frames form the ends of a torsion box which is closed by a stainless steel spot-welded stringer/skin construction. Skin is a special Firth-Vickers 80-ton high tensile stainless steel sheet which saved 400 lb. in this weight-critical area.

Steel Bolts

All steel bolts used by Vickers are machined with a slow taper as an anti-frettage device.

Direct support of the rear fuselage during landing is structurally desirable with rear-engine configurations and Vickers has distributed the wheel reaction through a triangular structure between the main strut attachment aft of the wing torsion box and the fuselage.

More than 50% of the transport's airframe will be milled from solid billets. Highlighting the production tooling and jigging installed—it includes 147 milling machines—is a punched card control jig borer which will be used on major bolting assemblies, to eliminate troublesome reaming operations on the line, and to increase the number of interchangeable structural components.

Fuselage Frames

Forged steel rear fuselage frames are mounted obliquely to increase the shear strength in this area, and a keel member which provides structural continuity under the landing gear cutout is of massive construction, 42 ft. long, 6 ft. deep, and 20 in. wide.

Reduxing, apart from its use in sandwich construction, is confined to reinforcement around cutouts, doublers and in the lamination of a few complex sections in the frames and floor members.

Elsewhere, the construction is conventional with frames and stringers running continuously, and the frames also are continuously cleated to the skin between stringers.

Vickers feels that there is little to

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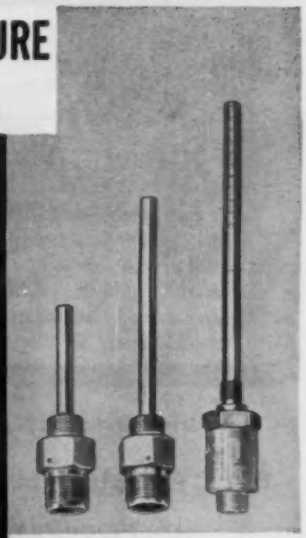

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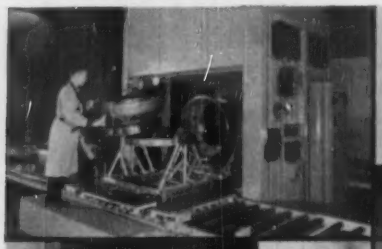
PRODUCTION RADIOGRAPHY — OX-250, in semi-automatic housing, checks turbojet components to assure defect-free welds.



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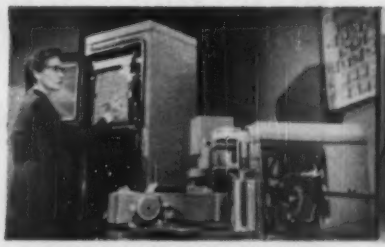

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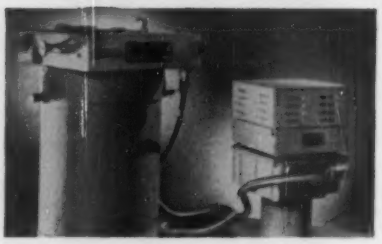

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choose between various flap systems. But the ability of utilizing the flap satisfactorily for takeoff is an advantage obtained with the Fowler flap and is achieved without any significant engineering penalty.

Slat Selection

The choice of slats instead of a drooped leading edge was based on aerodynamic advantages significant enough to justify the added complexity of the engineering and hardware. The de-icing problem has been met with the use of telescopic tubes which bridge the wing-slat gap.

Although the slats and flaps are interconnected, both can operate independently.

Flaps are made in 10 section and are motored through worm gearing from a torque shaft running the whole length of the flap section, and driven by duplex hydraulic motors. Failure of one motor or its associated hydraulic system only halves the flap development rate. Slats, which are divided into 16 sections, are similarly operated. Development of asymmetry in either system is sensed by a.c. phase difference units at the ends of the torque shafts. These cause the hydraulic motors to be isolated and the flap and slat extension arrested until the aircraft touches down.

Lift Coefficient

Full length slats and large chord Fowler flaps, both uninterrupted, double the lift coefficient of the basic VC. 10 wing.

A Vickers aerodynamicist explained that the flaps have been optimized for takeoff using a novel extension geometry which ensures 90% extension for only 20 deg. deflection. Takeoff distance under standard conditions, fully factored at gross weight, is 7,000 ft.

Approach speed of the VC.10, it was pointed out, was down to 100 kt. at its empty weight, rising to 122 kt. at a landing weight of 200,000 lb. Vickers also has devised a periscopic system which will be installed in the flight deck and will give the pilot an optical view of the jet pipes.

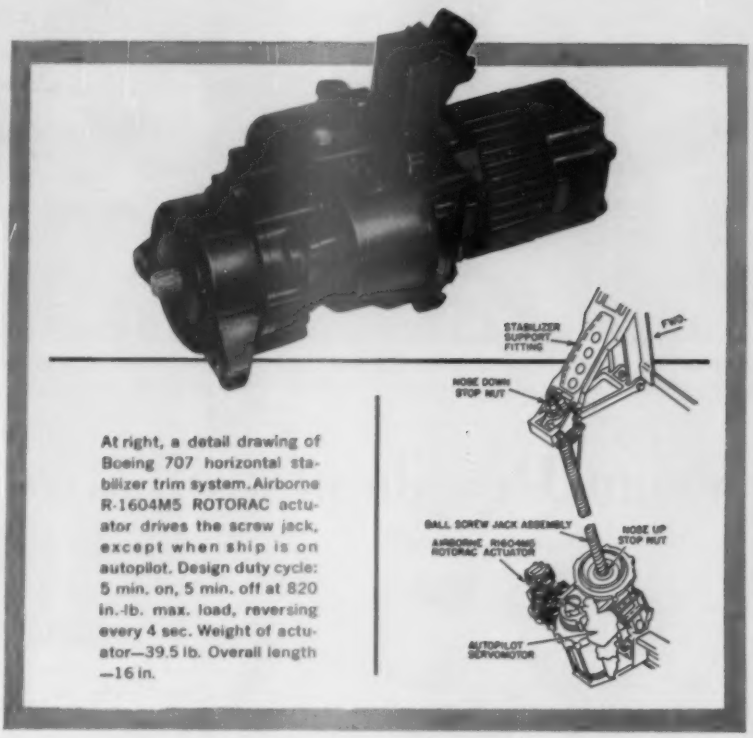
Short SC. 1 VTOL Makes Full Transition

Short Brothers & Harland SC.1 delta-wing VTOL research aircraft has completed the entire sequence of flight operations for which it was designed.

Transitions from jet-borne hovering to wing-borne forward flight and the reverse were made. Previously the aircraft had taken off vertically and hovered, using its four downward-pointing Rolls-Royce turbojets, and had flown conventionally on the single horizontally-mounted propulsion engine.

AIRBORNE SPECIAL ACTUATOR

POWERS 707 TRIM SYSTEM



At right, a detail drawing of Boeing 707 horizontal stabilizer trim system. Airborne R-1604M5 ROTORAC actuator drives the screw jack, except when ship is on autopilot. Design duty cycle: 5 min. on, 5 min. off at 820 in.-lb. max. load, reversing every 4 sec. Weight of actuator—39.5 lb. Overall length —16 in.

Because of its function—operation of a primary flight control on Boeing's 707 — this Airborne ROTORAC large special actuator must provide the utmost reliability under almost continuous off-on-reverse type operation. And its response must be quick, even though maximum torque and acceleration are limited by specification — to avoid inadvertent structural overloads.

To control torque, Airborne developed a special friction clutch which limits output to 1500 in.-lb. maximum and yet will transmit 1200 in.-lb. under any condition. Controlled accelerations were achieved by balancing the inertia characteristics of all rotating parts and of the external load against the carefully tailored performances of the motor and servo clutches. Result: smooth acceleration from 0 to 180 rpm in 0.4 second and shock-free reversal in 0.1 second, both at full load.

Airborne offers you engineering of this caliber to meet needs for almost any special rotary or linear electromechanical actuator—large or small. And where requirements are not unique, we provide a line of modular-type actuators, developed by Airborne to simplify design and specification. Just give us the facts on your application and we will be happy to make a proposal. Contact any of our offices for further information.

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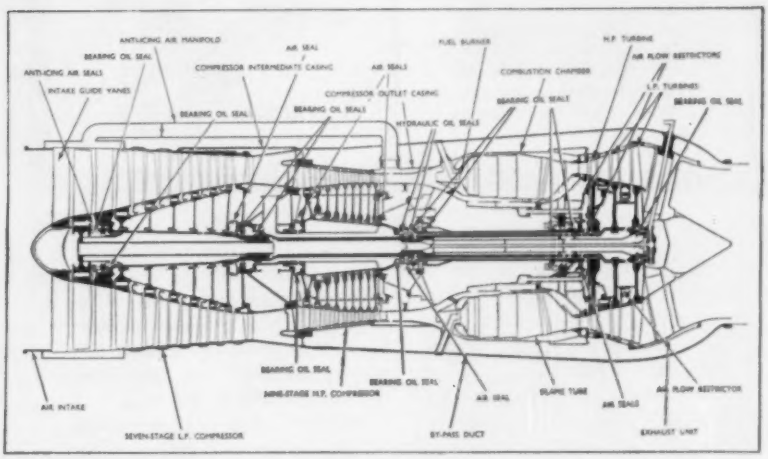
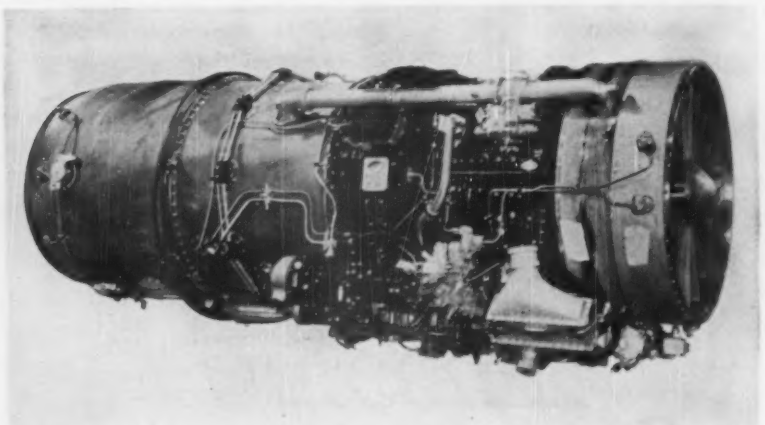
ROLLS-ROYCE CONWAY bypass turbojet is now in service with DC-8s, such as that of Trans-Canada Air Lines (above) and Boeing 707-420s. Specific fuel consumption at 36,000 ft., 475 kt., at 4,625 lb. thrust, is .900 lb./hr./lb. Basic dry weight is 4,544 lb.

Design Details of Rolls-Royce Conway



CUTAWAY of the RCo. 12. Both shafts rotate anti-clockwise, viewed from the rear.



CONWAY RCo. 12, Mark 509, for the Douglas DC-8. Over-all length is 131.6 in. Body diameter is 42.2 in. Seven-stage low-pressure compressor is driven by a two-stage turbine. A nine-stage high-pressure compressor is driven by a single-stage turbine.

By Robert I. Stanfield

Montreal—Bypass configuration of the Rolls-Royce Conway turbojet was designed to produce a low specific fuel consumption, a high power-to-weight ratio, and a minimum jet-noise level.

Intended for use in long-range transports, the civil Conway—the RCo. 12—is now in service with Boeing 707-420s and Douglas DC-8s.

The Conway includes a seven-stage, low-pressure compressor driven by a two-stage turbine. A nine-stage high-pressure compressor is driven by a single-stage turbine. The annular combustion chamber contains 10 straight-flow flame tubes and a bypass duct which surrounds the engine from the delivery of the low-pressure compressor to the outlet of the exhaust unit. A thrust reverser unit and silencer nozzle may be fitted to the engine.

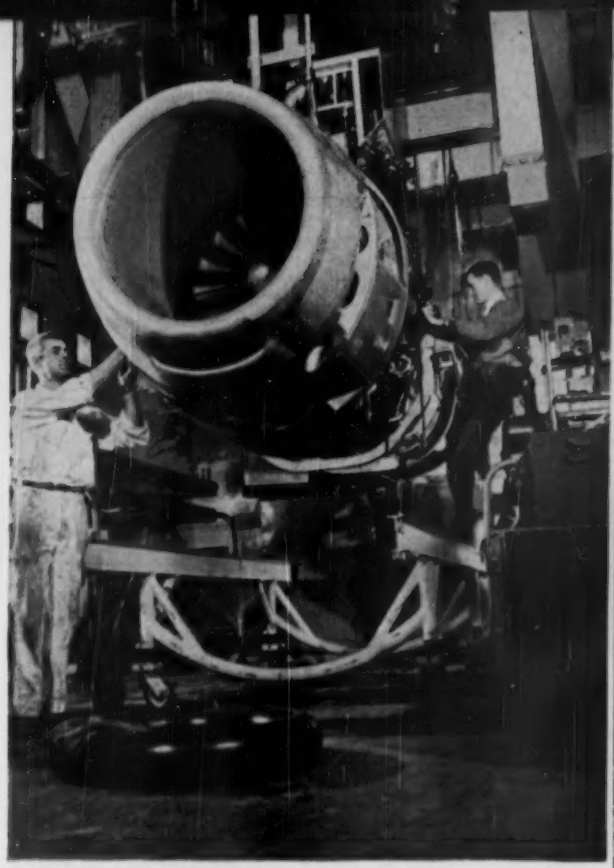
In the Conway's bypass configuration, the airflow from the low-pressure compressor is divided into two flows in the compressor intermediate casing.

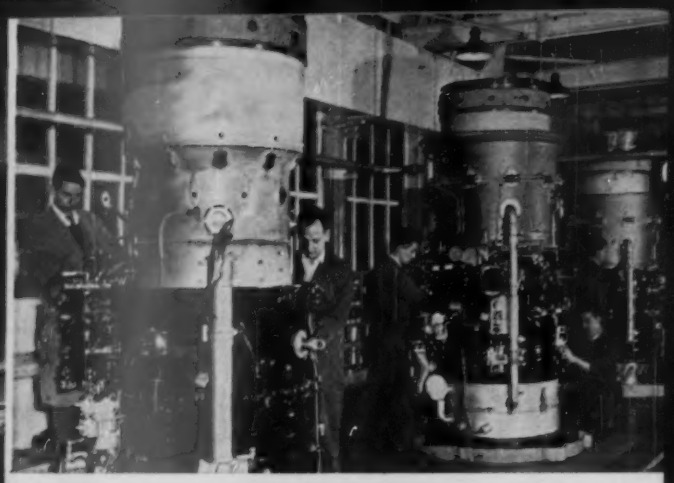
A large proportion is induced into the high-pressure compressor; the remainder flows on the outside of the engine through an annular bypass duct to the junction of the engine and jet pipe.

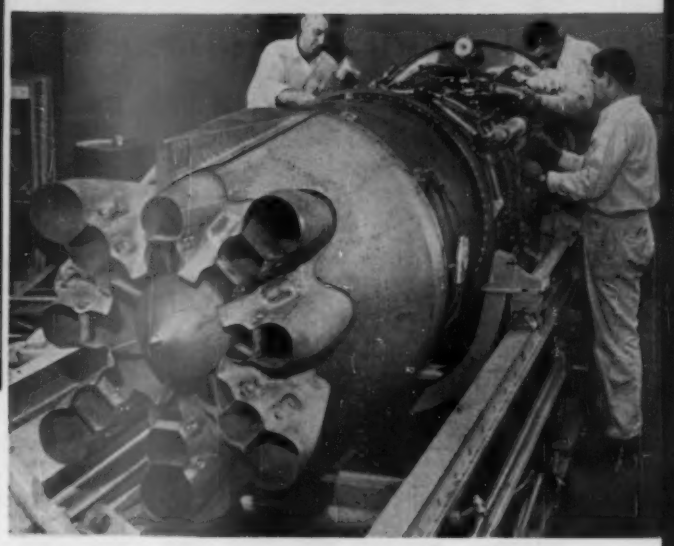
Bypass Advantages

Advantages of the bypass duct, as cited by Rolls-Royce:

• **Cool bypass air** joins the exhaust gases in the jet pipe, lowering the mean pipe temperature and reducing the velocity of the gas stream leaving the final nozzle, thus providing a high propulsive efficiency. Relatively high combustion chamber temperature of the







CONWAY MARK 509, above, being suspended in Trans-Canada Air Lines test cell at Montreal Airport, Quebec. The two TCA cells can take engines of up to 30,000 lb. thrust. Top, right, shows Conways on the assembly line at Rolls-Royce's Derby, England, plant. At right Mark 509 with Douglas engineered thrust reverser at TCA's maintenance base.

bypass engine maintains a high cycle efficiency. Combination of these two factors provides optimum conditions for low specific fuel consumption.

• **Jet noise level** is reduced due to the low jet velocity and the fire risk diminished by the blanket of cool air around the hot engine.

• **Engine sections** are scaled down in diameter and length, producing a lower total engine weight than that of a simple jet engine with the same airflow, due to the proportion of low-pressure air bypassing the high-pressure compressor, combustion system and turbines.

• **Assembly on engine** is facilitated by the two-section bypass casing. The front section is fitted before the nozzle box and turbines due to its smaller diameter. Rear section is bolted to the front section. Bypass air flows in the annular space formed by this casing and the engine main outer casings.

Rolls-Royce emphasizes that higher takeoff thrusts are automatically given by the Conway on cold days. Reason: the company's method of thrust limiting on compressor delivery pressure rather than exhaust gas pressure. Though rated under ISA (International Standard Atmosphere) conditions at a guaranteed minimum takeoff thrust of 17,500 lb., the RCo. 12 has been additionally approved by both the Air Registration Board and the Federal Aviation Agency for takeoff thrust of up to 20,000 lb.

The first Conway engine was run in August, 1952. As of Apr. 5, 1960, the bypass powerplant had accumulated 27,212 hr. of bench-hangar-flight time. RCo. 12s are starting out with 800 hr. between overhauls, which is expected to increase to 1,000 hr. before the end of 1960, 1,600 hr. before the end of 1961, and 2,000 hr. by mid-1962. By late 1962 1,000,000 hr. of airline service is expected, plus experience gained from military Conways in the Handley Page Victor 2 bomber.

Conway History

The first Conway prototype was the RCo. 2, turned out in January, 1950, which achieved 10,000 lb. thrust during bench testing. Next stage, the RCo. 5, was type tested at a dry rating of 13,000 lb. in August, 1955, intended for the Vickers V.1000 military transport. The V.1000 was canceled in November, 1955, following which an uprated version of the RCo. 5—the RCo. 8, which ran 14,500 lb. thrust during bench testing—was proposed for use with the Victor B.2. The RCo. 11, of 17,250 lb. thrust, was later produced for this aircraft.

The civil Conway line began with the RCo. 10, with a guaranteed takeoff thrust of 16,500 lb. The engine was originally offered to customers to commence airline service early in 1960, with the understanding that it would be uprated after about 12 months—in the field, at no additional cost—to give a guaranteed takeoff thrust of 17,500 lb. (the RCo. 12 rating).

Development proceeded at a rapid pace so that the RCo. 12 rating has been offered from the beginning of airline operation. Civil Conway variants include:

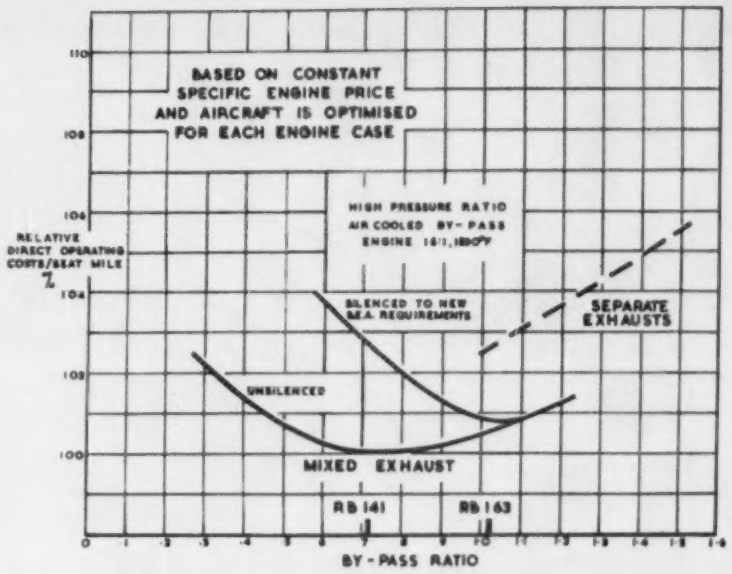
• **RCo. 12.** Minimum guaranteed takeoff thrust, sea level static, ISA, is 17,500 lb. Specific fuel consumption at 36,000 ft., 475 kt., at 4,625 lb. thrust, is .900 lb./hr./lb. Basic dry weight is 4,544 lb. Engines will be installed in the Boeing 707-420 (15 aircraft for BOAC, four for Lufthansa, two for Varig and three for Air-India) and in the Douglas DC-8 (six aircraft for Trans-Canada, six for Alitalia, and three of the four for Canadian Pacific).

• **RCo. 15B.** Minimum guaranteed

takeoff thrust, sea level static, ISA, is 18,500 lb. Specific fuel consumption at 36,000 ft., 475 kt., at 5,040 lb. thrust, is .864 lb./hr./lb. Basic dry weight is 4,582 lb. Improved performance over the RCo. 12 is achieved basically through increasing capacity (air mass flow) of the first stage of the low-pressure compressor. Prototypes can be delivered from September, 1960. The engine enters production April, 1961.

Modification kits for conversion of existing RCo. 12 engines to the 15B standard during overhaul will be available in the first quarter of 1961. These engines eventually will power Canadian Pacific's four DC-8s (flying 4,150 naut. mi. routes); the first three aircraft will take RCo. 12s to a high modification standard; the fourth will be delivered with the RCo. 15B in June, 1961.

• **RCo. 42/2.** Minimum guaranteed takeoff thrust, sea level static, ISA, is 20,250 lb. Specific fuel consumption, 36,000 ft., 475 kt., at 5,400 lb. thrust, is .800 lb./hr./lb. Basic dry weight is 5,001 lb. Additional thrust and improved fuel consumption is through use of an increased capacity low-pressure compressor and a rebladed low-pressure turbine to suit the new compressor. Selected bypass ratio is 0.6. High-pressure compressor, combustion equipment and high-pressure turbine are unchanged from RCo. 12 and 15 standard engines. Conversions of the latter engines (which would be extensive) can be accomplished with modification kits available in 1962. The RCo. 42 will go into production in December, 1961; the engine is intended for the Vickers VC.10 transport and large freighters o about 350,000 lb. maximum gross weight.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SEPARATE EXHAUSTS
UNSILENCED
MIXED EXHAUST
RB 141
RB 163
BY-PASS RATIO

CHART SHOWS DIRECT operating costs for 1,000-naut. mi. stage against bypass ratio indicating an optimum between a 0.7 and 1.05, depending on noise requirements.

About 265 civil Conways have been ordered. Of these, 259 are RCo. 12s (155 Mark 508s for the Boeing 707; 104 Mark 509s for the Douglas DC-8); six are RCo. 15B Mark 512s, ordered for the DC-8 (Canadian Pacific).

For the RCo. 12s utilized with the Boeing 707-420, Rolls-Royce manufactures the pod, thrust reverser and si lencer. More than 2,000 hr. of benc and pod running have been accumulate with the thrust reverser. A complet Boeing pod installation has finishe 1,600 hr. of hangar running and 1,000-hr. simulated flight test. For th Conway-engine DC-8s, only the bar engine is supplied; Douglas enginee the pod, thrust reverser and silencer.

In North America, Trans-Canad Airlines will overhaul its own engines at its new $20 million overhaul and maintenance base at Montreal Airport, Dorval, Quebec. Its first DC-8 was delivered in February, the second in March; the sixth is scheduled for November. Canadian Pacific will use Trans-Canada's facilities. Chances are, too, that Alitalia will contract for overhaul work at Dorval. Trans-Canada also will assist BOAC with line maintenance on this side.

Trans-Canada's Conway spares will come from Rolls-Royce's Derby, England, plant. Rolls-Royce of Canada (Montreal) will suppy Canadian Pacific spares, and will adjust to the needs of the situation regarding engineering and technical support as required.

Trans-Canada also is making provi-

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If America's first man-carrying rocket runs into trouble, a unique Donner device will play a vital role in bringing the Astronaut safely back to earth.

Known as a "maximum altitude sensor," the all solid-state system is essentially a fixed purpose miniature analog computer housed in a magnesium case only five inches long. Installed in the capsule, it goes into action if it is necessary to abort the rocket flight before the Astronaut's escape tower is jettisoned.

What It Does

The Donner device, which was developed for McDonnell Aviation with the approval of NASA, provides programmed time delay that operates rescue devices at maximum altitude.

Under abort conditions, the maximum altitude sensor provides output information which will:

1. Energize devices for firing the explosive bolts holding the escape tower onto the top of the capsule. This allows the escape tower to separate.

2. Energize the system which causes the escape tower jettison rocket to fire. With the tower separated, barostats are armed to open parachutes and furnish the Astronaut's capsule a safe descent.

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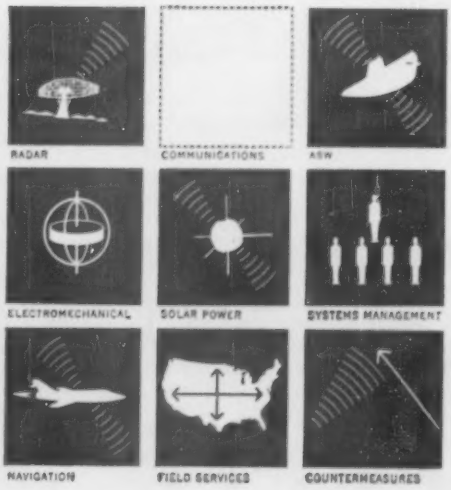

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sions for some of its DC-8s to fly a fifth engine in a bullet-shaped pod under the wing (for ferrying of engine spares to line stations; three-engine aircraft ferry flights in jets are not authorized). The airline has two test cells built specifically for the Conway (both air intakes and the cells themselves can take engines up to 30,000 lb. thrust). Trans-Canada has been getting an average 18,000 lb. thrust on normal engines received from Rolls. Some have drawn corrected thrust of 19,000 lb. in the cell, where they are suspended, rather than floor-mounted.

The Conway will go into service with Trans-Canada at an 800-hr. overhaul life. "Looking process"—two engines off at 600 hr.—will mark extension of overhaul life by 100-hr. increments, with sampling program. Trans-Canada aims for three times the initial entry of 800 hr.

Further Development

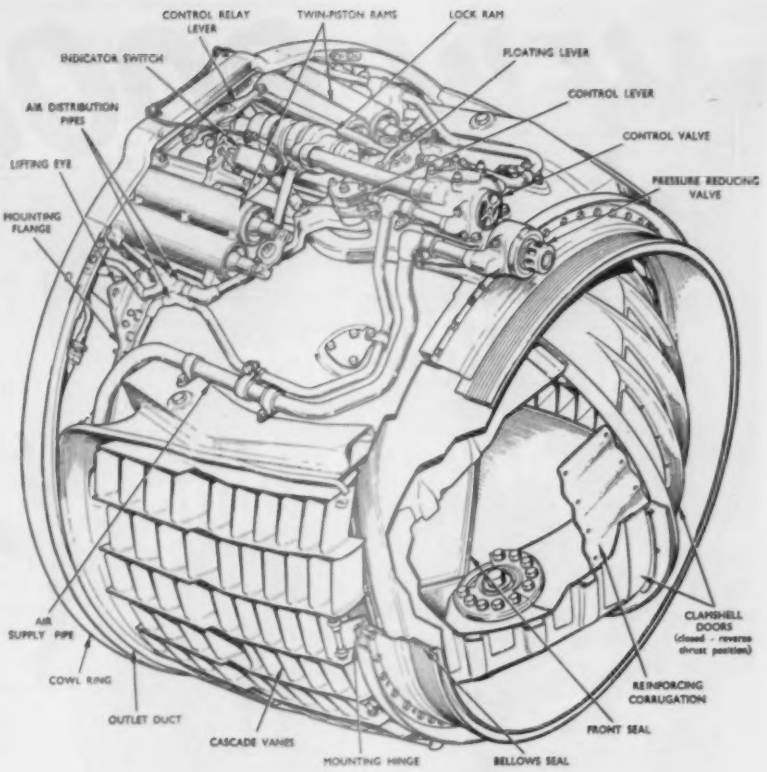
Further development of Rolls-Royce civil bypass engines—the next generation—will run to higher bypass ratios than current Conways and will include the following project-numbered powerplants:

• **RB. 163.** Powerplant will be used with the three-engine Airco DH-121 transport. The two-spool engine has a four-stage low-pressure compressor driven by a two-stage low-pressure turbine, and a 12 stage high-pressure compressor driven by a two-stage high-pressure turbine. Bypass ratio is 1.0. Pressure ratio is 16:1. Minimum takeoff thrust, sea level static, ISA, is 9,850 lb.; specific fuel consumption is .578 lb./hr./lb. At 25,000 ft., 525 kt., at 2,200 lb. thrust, specific fuel consumption is 0.79. Basic dry weight is 2,315 lb. First engine is scheduled to run in August.

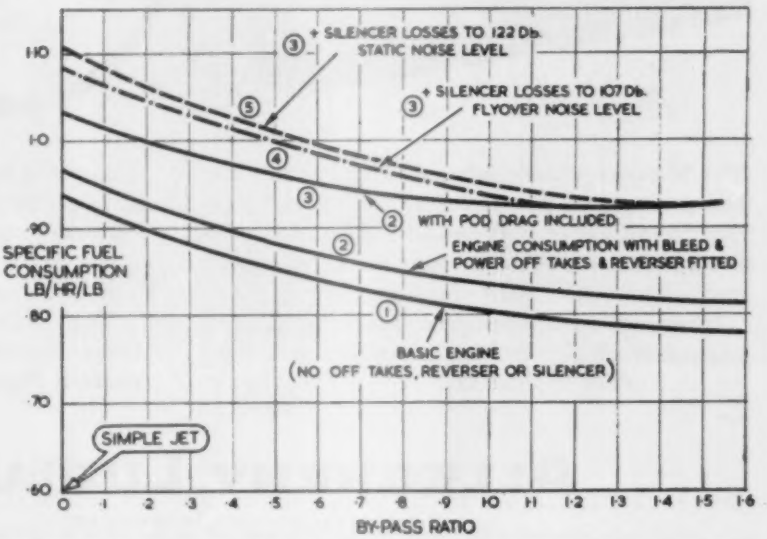
• **RB. 141.** Development running began on this engine last November; it is the basis of the new bypass family. The engine will be rated at 15,000 lb. minimum takeoff thrust. Bypass ratio is .7. Powerplant is applicable to the improved Sud Aviation Caravelle. Production, depending on commitments, could begin in early 1961.

• **ARB. 963.** Engine is a development of the RB. 163, in the intermediate thrust class (11,500 to 12,500 lb.). Powerplant may be produced here by Allison Division of General Motors, which is negotiating with Rolls-Royce on a licensing agreement (AW Mar. 21, p. 23). Another likely prospect for Allison is the AR. 970, a Conway seven-stage engine in excess of 20,000 lb. thrust.

Main structure of the Conway engine is formed by a number of basically circular casings secured together by flanged joints to form a rigid structure, inside which the main rotating assembly



ROLLS-ROYCE THRUST reverser for RCo. 12, Mark 508, utilized with Boeing 707-420.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SIMPLE JET
SPECIFIC FUEL CONSUMPTION LB/HR/LB
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1·0
·90
·80
·70
·60
0 ·1 ·2 ·3 ·4 ·5 ·6 ·7 ·8 ·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6
BY-PASS RATIO

SPECIFIC FUEL consumption for subsonic cruise condition plotted against bypass ratio.

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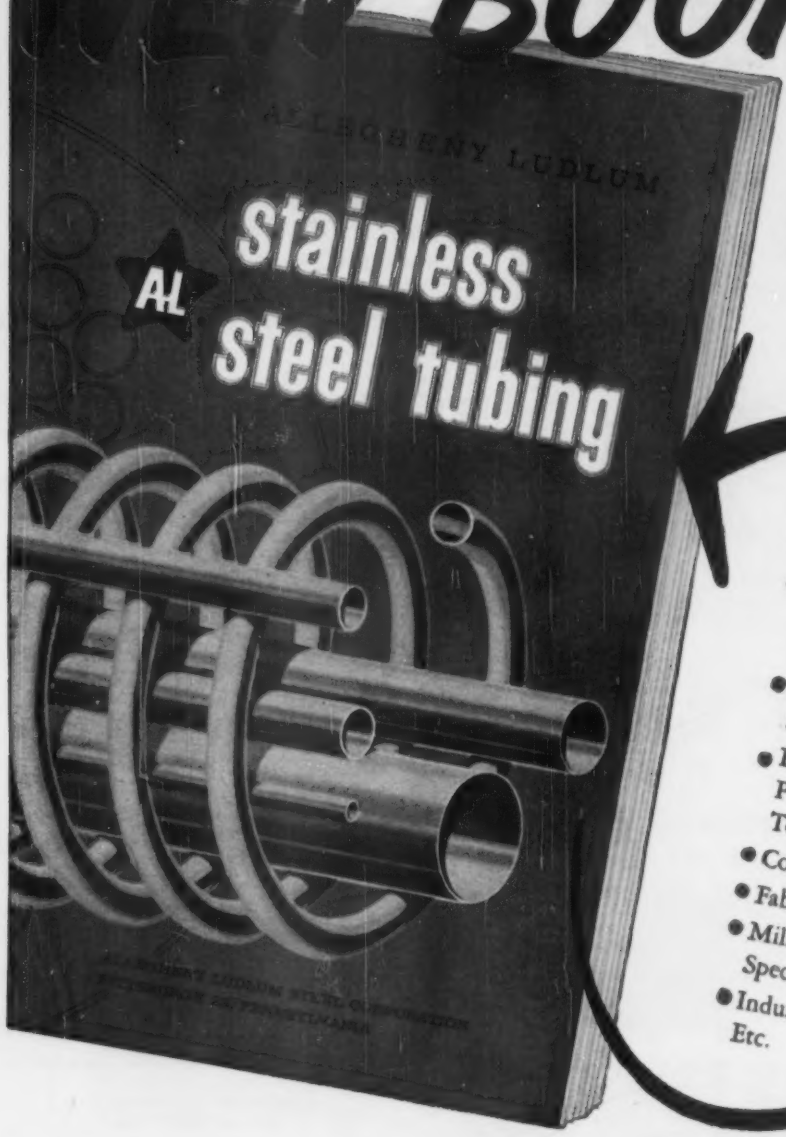

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Rolls-Royce RCo. 12, Mark 509

Performance:	Engine Speed	Thrust	Sfc. (lb./hr./lb.)
Maximum takeoff	9,980 rpm.	17,960 lb.	0.725
(5 min. limit)		(17,500)	(0.745)
Maximum continuous	9,590 rpm.	15,000 lb.	0.690
(unrestricted)		(14,625)	(0.705)
Cruise: 475 kt. at 36,000 ft. ISA	9,240 rpm.	4,625 lb.	0.900
Max. recommended climb engine speed	9,440 rpm.		
Max. recommended cruise engine speed	9,240 rpm.		

(Nominal performance at sea level ISA static conditions. Figures in parentheses are the minimum ratings.)

Specifications:

Type: Bypass turbojet, two spool.

Turbine: Axial, two-stage low pressure, one stage high pressure.

Compressor: Axial, seven-stage low pressure, nine-stage high pressure, 280 lb./sec. airflow, 15:1 ratio.

Combustion: Annular, 10 straight flow flame tubes.

Dimensions-weight: over-all length 131.6 in.; body diameter 42.2 in.; basic dry weight 4,544 lb.

Associated equipment: Silencer, reverser and pod assembly—Douglas supply.

(Note: The Mark 509 is utilized with the Douglas DC-8. The Mark 508, utilized with the Boeing 707, differs only in these respects from the former: Maximum recommended climb engine speed is 9,500 rpm. Basic dry weight is 4,542 lb. Over-all length is 35.9 in. Associated equipment includes fixed nozzle with corrugated silencer and thrust reverser; pod assembly is Rolls-Royce design.)

is supported by ball and roller bearings. Casings are accurately located by radially positioned dowels, spigots and close-fitting bolts. Unified threads are used throughout the engine.

Heat-resisting steel alloys are used for the air intake casing and the front bearing housing fabrications through which anti-icing air flows. Front bearing housing is fabricated from an outer casing, 31 hollow first-stage low-pressure stator blades and an inner support ring. The latter carries the flanged outer race of the low-pressure compressor shaft front bearing. Anti-icing air from the manifold flows through all 31 blades when required. Three of the blades are used to carry oil tubes; one feeds the front bearing and two return scavenge oil.

The low-pressure compressor casing is of aluminum alloy and the intermediate casing of magnesium alloy. Engine thrust is transmitted to the airframe through mountings on the intermediate casing. Heat-resisting alloys are used for the high-pressure compressor and outlet casing, and for the combustion chamber and exhaust unit, all of which are fabricated assemblies. The bypass duct, which envelops the engine from the intermediate casing to the jet pipe, is formed from titanium.

Two compressor rotors are directly driven from separate turbines through coaxial splined coupling shafts. Low-pressure and high-pressure rotating assemblies are not mechanically connected. Engine speed is that of the high-pressure compressor with which the low-pressure compressor finds its own equilibrium speed within limits set by maximum speed governors for each compressor.

The low-pressure turbine shaft is in two sections and rotates within the high-pressure turbine and compressor shafts. Helical driving splines, used to connect the turbine shafts to the compressor shafts, permit variations in alignment over the engine length within specified limits. Threaded couplings locate the shafts axially and provide means for adjustment to obtain axial running clearances.

Seven wheels of the low-pressure rotor are located on the two-piece shaft. The second-stage wheel and short front section of the shaft are integral; the first-stage wheel is taper-bolted to the front end of this shaft. Rotor blades are attached to the wheels by steel pins retained by spacer rings. Blades in the first six stages are of aluminum alloy; the seventh-stage blades are of titanium.

The high-pressure rotating assembly has a two-piece shaft and nine rotor wheels and blades. The first-stage wheel is bolted onto the front section of the shaft.

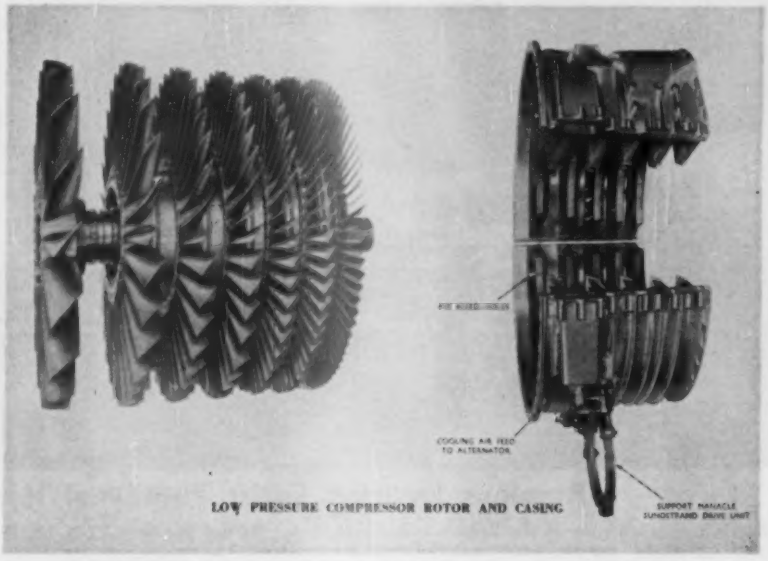
Second Stage Wheel

The second-stage wheel, like the following seven wheels, has a hair-pin sectioned hub and is secured by bolts which join the two sections of the shaft. Remaining wheels are splined to the rear section of the shaft.

Titanium rotor blades are located in each of the rotor wheels by hollow steel pins. Pins are retained by steel rings on each side of each wheel. The rings are segmented and have locating tangs which fit into slotted grooves around the periphery of each wheel.

Drives for external engine units and engine-driven accessories are taken from a spur gear splined to the high-pressure compressor shaft and through an internal wheelcase to a port and a starboard side wheelcase, on which units are mounted. A separate drive, taken from a spur gear splined to the low-pressure intermediate shaft, drives the low-pressure tachometer generator.

Fuel is supplied to duple burners by a dual multi-plunger high-pressure pump. An engine-driven backing pump ensures adequate pressure at the main pump inlet. Fuel heating by high-pressure compressor delivery air protects



SEVEN WHEELS of the low-pressure rotor are located on a two-piece shaft (left). Five stages of aluminum alloy blades are contained in the split aluminum casing (right).

Yakovlev Backfin Tactical Bomber

Yakovlev Backfin tactical bomber was first flown in the summer of 1957. Powered by two 17,000-lb.-thrust turbojets, it was designed as a supersonic replacement for the Il-28 Beagle tactical bomber which is in wide service in the Soviet air force and in the satellite countries. Backfin apparently has not yet reached operational service.

against icing at the low-pressure filter.

Ten interconnected flame tubes are situated between the high-pressure compressor outlet casing and the nozzle box, and between an inner and outer air casing, forming an annular combustion chamber. A fuel burner is mounted in the center of each flame tube snout. A high-energy igniter is positioned in each of two flame tubes for initial light-up when starting.

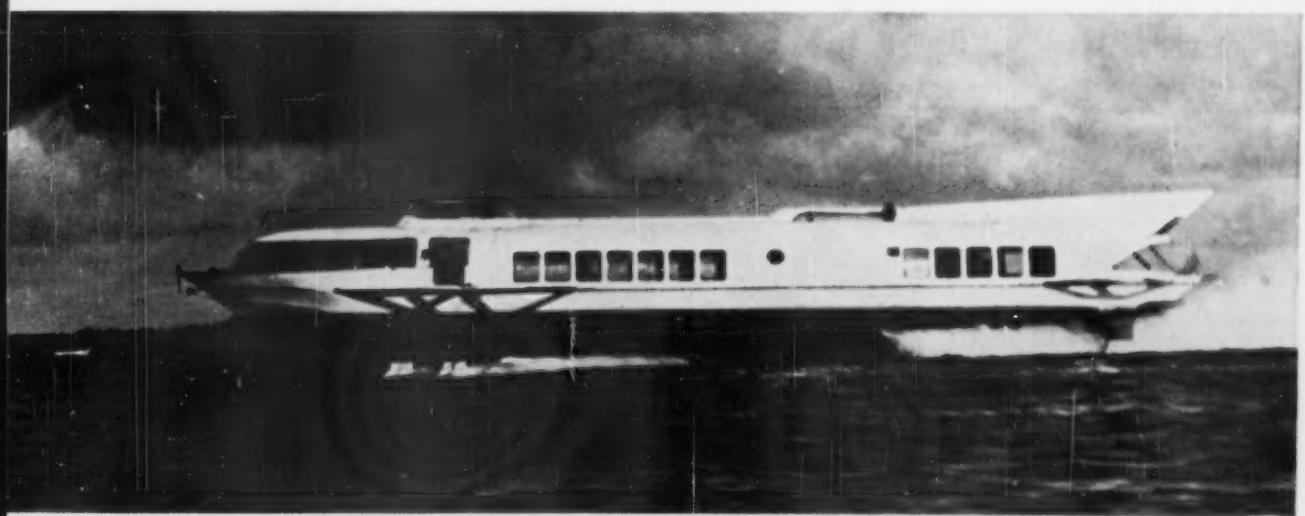
Lubrication is by continuous circulation system self-contained on the engine. Oil leakage is prevented by air-pressurized labyrinth seals except for the low-pressure compressor thrust bearing, where piston-ring type seals are used. Low-pressure air is used to pressurize the oil seals and cool the main rotating shaft bearing housings (the flow to the low-pressure turbine tail bearing is taken from the bypass duct).

To cool turbine disks, and the high-pressure nozzle guide vanes and turbine blades, high-pressure air is taken from the inner casing of the annular combustion chamber.

For anti-icing purposes, hot air from the high-pressure compressor delivery is ducted to a manifold around the engine air intake by two external pipes. Flow of air is controlled by means of a regulator valve in each pipe. Hot air from the manifold is taken to the inlet guide vanes, engine nose fairing and first-stage low-pressure stator blades and is returned to the manifold from which it is vented to atmosphere.

Engine is started by a low-pressure air starter, used in conjunction with high-energy ignition system. A Sundstrand drive unit is attached to the engine to provide a constant-speed drive for an alternator which supplies electrical power at constant frequency.

For wing installations engine mounting trunnions are provided on each side of the intermediate casing horizontal



Russians Envision Entire Family of Hydrofoil Boats

Results of tests centering on this Russian hydrofoil boat, the "Meteor" (AW Mar. 14, p. 113), will be used in development of a family of hydrofoils ranging from six-passenger sports models to the proposed "Sputnik," which designer R. I. Alekseev says will carry 300 passengers at better than 65 mph. Meteor carries 150 passengers and is powered by two diesel engines. Boat is 110 ft. long, 21 ft. wide and displaces 52 tons. Alekseev indicates future models will use turbine powerplants.

center line; slinging eyes are provided on the intermediate casing and at the rear of the engine.

Engines to be fitted in power unit pods are suspended by saddle mountings on the top of the intermediate casing and by a rear suspension. The latter engines, which are underslung, are provided with handling trunnions on the intermediate casing and with jacking pads.

French Order Three Mirage IV Bombers

Paris—French government has ordered three Dassault Mirage IV preproduction tactical strike bombers. A single Mirage IV prototype now is flying although the government eventually expects to order 50 of the Snecma Atar-9-powered jets (AW Mar. 7, p. 288).

The Mirage IV is slated to become the nucleus of a French atomic strike force. Deliveries are scheduled for 1963.

In another French aircraft development, Peru has ordered five Morane-Saulnier twin turbojet executive aircraft, powered by Turbomeca Marbore 2 engines. To date, 11 foreign countries have ordered about 80 of the four-place jets. French government has ordered 50 for military uses. During 1959, the French aircraft industry booked orders worth $86 million, an increase of $8 million over 1958.

Observers expect this year's figures should double those of 1959, largely due to orders expected for civil aircraft such as the Sud Caravelle and the new French feederliner, the Max Holste Super Broussard.

Of the total 1959 orders, some $16 million were for French tactical missiles, mostly Nord Aviation's SS-10 and SS-11 anti-tank missiles.

One changing aspect of the industry's order book is that for many aircraft more orders are being booked by foreign buyers than by the industry's traditionally best customer, the French government.

First F-104A Drones Begin Flight Tests

Los Angeles—First of 24 early model Lockheed F-104As scheduled for conversion to target drones is being test-flown at Palmdale, Calif. The QF-104s will have a pilot aboard during initial testing of the stabilized automatic pilot and radio-radar command system. First unmanned flights are scheduled for November at Eglin AFB, Fla.

Drone conversion of four of the early-model aircraft is set to be completed by November. Delivery of the 20 follow-on QF-104s will begin in March '61.

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Douglas Plans Automated Cargo System

By Russell Hawkes

Santa Monica, Calif.—Douglas Aircraft Co. plans to offer an entirely automated and mechanized portal-to-portal air cargo system to military and civil air cargo carriers, rather than just a jet all-cargo airplane.

Douglas calls the civilian version the Total Air Cargo System but will sell its elements separately, if necessary. The military version is called Materials Handling Support System 463L. Study phase of the USAF contract is just completed. Associate contractors are International Business Machines Corp. and Arthur D. Little Co.

Many companies are studying a system approach to the air cargo business, but nothing has yet reached the carriers.

Douglas officials report that the airlines are far from unanimous about what they want in such a system.

The airlines and Military Air Transport Service are the only cargo haulers in the U. S. who have failed to integrate terminal cargo handling and the cargo vehicle in a single system. The practice of requiring a shipper to deposit his cargo at the airport for retrucking to an airplane on the flight line would be equivalent to using small boats to load a merchant ship anchored in the middle of the harbor, an observer noted.

Cargo Piers

Douglas proposes to cut airplane turnaround time by using the equivalent of waterfront piers at permanent major terminals. Land transport lines are to have easy access to the loading facility, where cargo will be preloaded on mechanized conveyances for quick loading of the airplanes arriving at the other end of the facility.

Civil and military interest in improving the ground elements of the air cargo system stems from the fact that as aircraft become faster, time lost on the ground bulks larger in the total time needed to carry an item from where it is made or stored to where it is needed. By the same reasoning, a dollar spent on improved ground handling of cargo will yield a proportionately larger return in quality of service.

However, direct operating costs accrued by flying the aircraft are twice indirect operating costs accrued by the ground operations serving the cargo fleet, so turbine-powered airplanes will still provide a bigger cost reduction. The way to build air cargo volume is by reducing the rates charged to shippers. This can be done only if costs are reduced.

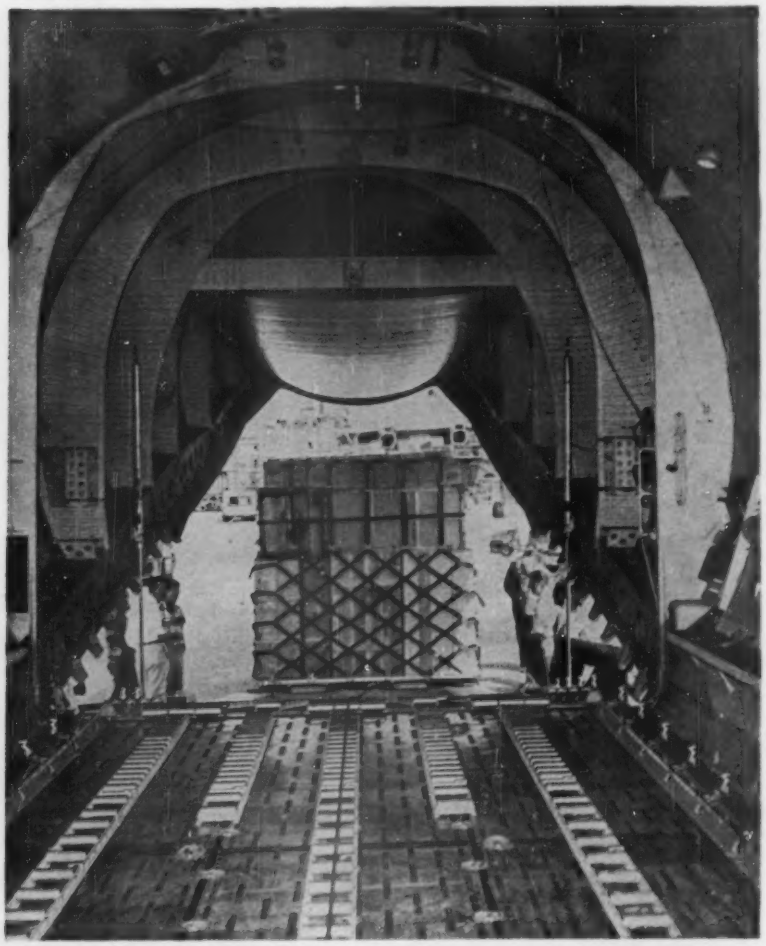
If domestic air cargo rates can be brought down from the present 21 cents per ton mile to 10 cents per ton mile, air cargo volume should rise from 400 million ton miles per year to 5.5 billion ton miles, according to Lloyd Ashenbeck, head of the Douglas market analysis group.

Operating Costs

Direct operating costs are now set at about eight cents per ton mile, but according to Douglas calculations, the advent of the cargo jets should bring the figure down to four cents per ton mile in 1965. If indirect costs can be held in their present ratio to direct costs, the 10 cent per ton mile rate would be possible. The indirect costs could be lowered partly by increased traffic volume which would spread fixed costs over a larger number of revenue producing ton miles of traffic and partly by improving efficiency of ground elements in the system.

Douglas calculations of market potential are based only on penetration of markets now served by surface transport means. There is ample room for penetration. Air cargo now represents only 0.03% of the total domestic freight movement. Douglas calculates that 0.50% should fall within the rate potential of modern aircraft. Total freight movement in the United States is 1.4 trillion ton miles per year.

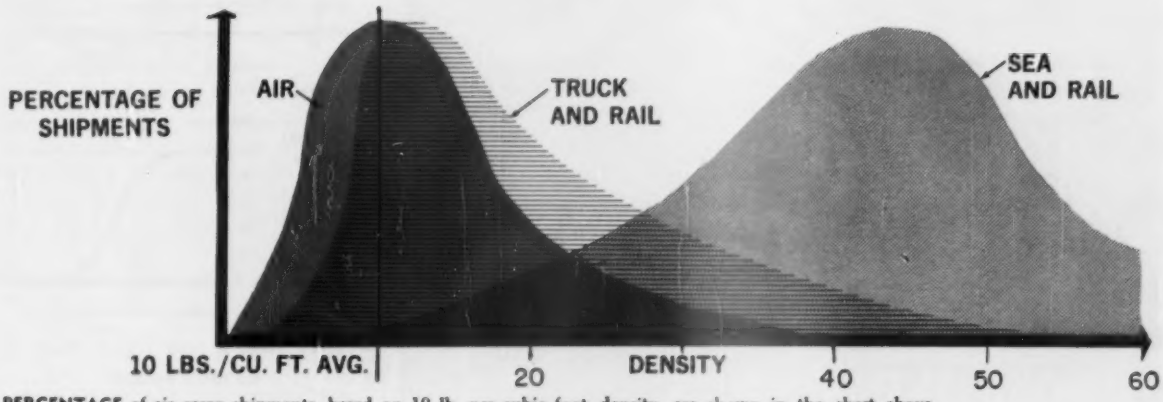
Most analysts agree that this forecast of the air cargo slice is not unreasonable and some independent organizations have reached conclusions far more optimistic. While airline officials agree



AIR CARGO is palletized for loading into a C-133 transport in a test run at Douglas.

CARGO AIRCRAFT DESIGN FACTORS

$$\frac{\text{WEIGHT}}{\text{VOLUME}} = \text{DENSITY (LBS. PER CUBIC FOOT)}$$



PERCENTAGE of air cargo shipments, based on 10 lb. per cubic foot density, are shown in the chart above.

that the cargo market is a good one, it seems that another two years must pass before the trunklines will get their money back from passenger jet investments. Unless Congress passes a guaranteed loan bill, there is little probability of new companies appearing on the air cargo scene. The concentration of capital and experience needed is too difficult to obtain.

Douglas is expending most of its effort in analyzing the market for city pairs 800 or more miles apart. At shorter distances the speed advantage of aircraft over trucking becomes marginal, Ashenbeck said. Statistics on the origin and destination of Logair cargo shows a need for both short range and long range aircraft. Cost studies indicate that long range cargo jets are likely to be uneconomical at ranges under 900 mi.

Present military and commercial air cargo systems are a paradox in which long-haul traffic must move over short and medium haul routes. About 50% of the tonnage carried by Logair moves distances between 1,000 and 2,260 mi. About 85% of commercial traffic moves distances of 1,500 mi. or more. Despite this evidence of need for long haul routes, the average scheduled distance for commercial air cargo is 627 mi. This imposition of a feeder route structure on long haul traffic is produced by the limitations of existing cargo aircraft and the wide dispersal of traffic generating communities.

Turbine aircraft can eliminate one factor and increased traffic volume can eliminate the other. Already, more nonstop long haul cargo services are being inaugurated. As volume increases, more such routes will be economically self-sustaining and more range will be demanded of aircraft.

Setting up the range requirement for proposed cargo jets involves difficult compromises. About 20% of military overseas cargo moves between 500 and 2,200 naut. mi. An airplane with a range of 3,500 naut. mi. could serve 60% of present logistic needs. Increasing the range to 4,500 mi. would add only 20% to the logistic capability. At ranges beyond 3,500 mi. payload must be sacrificed to carry more fuel.

The critical leg in domestic cargo flying is the 2,260 naut. mi. New York-San Francisco run. Since commercial operations can use en route refueling stations, most international range requirements also are met within this distance. An exception is the North Atlantic route where weather conditions and reserve fuel requirements make it desirable to eliminate this stop at Gander, Newfoundland. This would demand a 3,000 naut. mi. nonstop range plus reserve for headwinds. Douglas experts figure it is more economical to maximize payload at the expense of range rather than trading payload for fuel.

Aircraft Size

Size of the airplane also must represent a compromise. For a given traffic volume, large aircraft can expect to have a smaller load factor. However, an overriding consideration is the relationship between operating costs and frequency of service. For payloads up to 160 tons per flight, it can be shown that a fleet of large aircraft will have smaller operating costs despite their smaller load factor. According to Douglas calculations, the four cent per ton mile cargo airplane can be found in the DC-8 size range. The company argues that if cargo airplanes are designed for payloads much smaller, costs and trip frequency will be too high and range and growth potential will be limited. A larger aircraft also may offer greater flexibility in range.

Though rates three to eight times as high as surface transportation have held back the growth of commercial air cargo, future expansion is not dependent on exactly matching the rates of surface carriers. It is quite well established that the speed offered by air transportation can reduce the amount of capital tied up in inventories. The cost of crating and the risk of loss and damage are less in air cargo.

Air Force officers have noted that current jet transports obviously were never intended as cargo carriers. They are high deck, side loading versions and, in some cases, cargo loads may be volume limited rather than weight limited because of inefficient cabin shape and the low density of most frequently carried air cargos. Douglas investigations show that in commercial cargo operations, nine prime cargoes constitute 50% of the traffic. They are wearing apparel, machinery and parts, aircraft parts, flowers, electrical equipment, auto parts, scientific instruments and drugs. Many of these items are made of dense materials, but constitute a low density cargo because awkward shape or packaging necessities make it difficult to use volume efficiently.

Average cargo density in commercial operations is 10 lb. per cu. ft. If cabin dimensions were based on this figure, the airplane's payload would be volume-limited 50% of the time. An airplane could carry full payload 80% of the time with a density of 8 lb. per cu. ft.

It would be uneconomical to design a fuselage for cargo densities low enough to carry 100% of payload under all conditions.

Air Force would buy a specially de-

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signed cargo jet if it had the money. However, with funds being scarce, Air Force plans to buy an existing airplane off-the-shelf with a bare minimum of necessary and practical modifications. The swing-tail is thought to be both. Douglas officials say the target for cargo handling systems is to be able to offload one cargo and reload the aircraft with a new cargo in the space of time required to refuel the airplane. Considering the speed of underwing, pressure fueling, this is an ambitious target.

Military services want a slightly lower design cargo density than that calculated for commercial operators. Cargo densities of a Thor ICBM missile squadron and a typical Strategic Army Corps deployment are preponderantly below 10 lb. per cu. ft. A study of Air Force general cargo indicates that it is generally 5 lb. per cu. ft. or less. Most of the shipments considered were carried by truck and rail and consisted of a variety of commodities which could well be carried by air. From these studies it has been concluded that a MATS cargo jet should have a design density of 7 lb. per cu. ft.

Integrated Systems

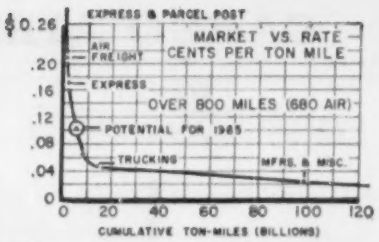
Sam A. LaMar, chief of Project 463L at Douglas, says that ultimately the military services and the economy must integrate cargo handling systems for all types of transportation. This would include the means of documentation, marking and labeling, and communication as well as the actual movement of goods. This is not a new idea; railroads and trucking firms studied the joint use of large permanent containers to be carried on special truck beds and flatcars as much as 35 years ago.

The idea was dropped as not being worth the initial investment. Now it is being reconsidered because of high labor costs. It could eliminate one stage of loading, and mechanized handling techniques could reduce costs even further. Integration of air, truck and rail techniques would ease the shifting of cargo from one transport system to another to provide the most flexible service.

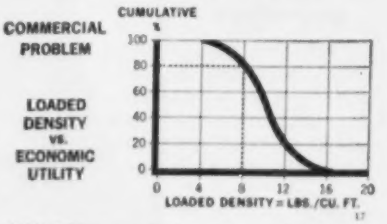
The type of equipment used in the terminal must be determined by the volume of cargo flowing through it. Traffic must be great enough to provide a return justifying the initial investment. This would seem to portend use by commercial operators of mobile equipment similar to that proposed.

Air Force has another project team engaged in defining hardware requirements for a world-wide Air Force communication system. Its members are alert to the needs established by 463L which will have to work within the framework they establish.

LaMar's project team has analyzed



AIR cargo costs are projected above.



UTILITY range is from 4 to 16 lb./cu.ft.

AIR FORCE FREIGHT

UNIT	PERCENT 10 LBS./CU. FT. OR LESS
THOR MISSILE SQUADRON	52
AIRBORNE DIVISION	45
GENERAL CARGO	47

THOR missiles have lowest cargo densities.

the flow of cargo traffic through Air Force terminals in all parts of the world. They have found that about 4% of all Defense Department tonnage moves by air.

They believe this figure should be increased to about 15%.

A weapons phasing group meeting is scheduled this week at Travis AFB, Calif., and is expected to plan procurement of service test quantities of system elements as well as the service tests themselves.

In the past, only 1% of Army and Navy cargo has moved by air. Low cost transportation provided by turbine-powered cargo aircraft is expected to increase Army air cargo by 5% of its total by 1965. This alone will add 350 million ton miles per year to military air cargo traffic.

In the cargo jets and materials handling support system (463L), Air Force hopes to find the means of cutting the period between requisition and delivery at any point in the world to 10 days. Air Force and commercial carriers both must be prepared to operate at a variety of types of bases and with older aircraft as well as the proposed cargo jets. The sophisticated loading dock concept is considered ideal, but troop deliveries are likely to mean operations in and out of unprepared advanced bases.

A self-propelled cargo loader has been proposed as a vital unit in advanced base cargo terminals. It would be a mobile conveyer mounted on lifts and

would be capable of moving 40,000 lb. loads to either high deck or low deck aircraft. The conveyer would double as a treadway for vehicles. End loading of aircraft is preferred by Air Force and all other experienced carriers. However, both commercial and military operators will have to adopt an evolutionary approach, beginning with equipment able to improve the operation of current aircraft.

There are permanent, semi-permanent and temporary MATS air freight terminals. A typical semi-permanent terminal might be found at a major airport in a foreign country where military or political circumstances could require sudden expansion or rapid abandonment.

Expendable Terminals

Temporary terminals are expendable and ordinarily are at the end of the line for air cargo. This is the so-called airhead. It has no fixed facilities because it must be set up where it is needed. Equipment for such bases must be air transportable, self-propelled and able to operate immediately on arrival at the airhead. Environmental differences and varying distances between terminal and aircraft are being anticipated in Project 463L.

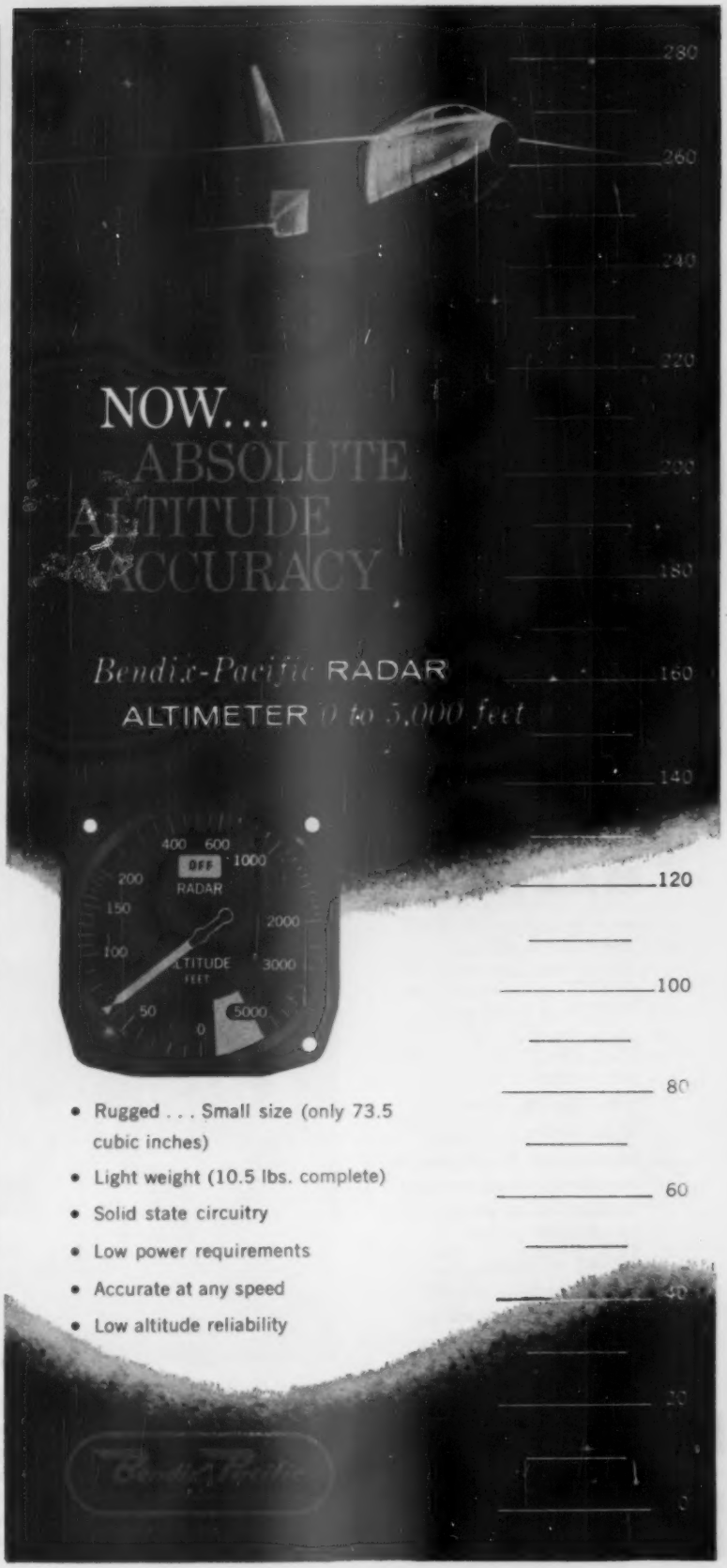
Air Force already has asked industry for bids on several items in the materials handling support system. About 40 manufacturers are said to be interested in making elements of the system. Proposals have been received on a standard rigid pallet with a lip at the edge to run under L-section guide-rails in the aircraft floor. Pallets are to be 9 ft. long, 7 ft. wide and 2 in. thick. This is the first part of Project 463L to be funded.

The next problem is the handling of cargo between terminal and aircraft. Airhead operations will require mobility of the equipment designed for this purpose. The necessity of moving cargo from 300 ft. to 3 mi. between terminal and aircraft is likely to survive for a while.

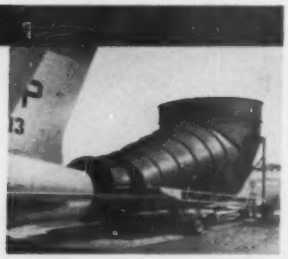
Container Plans

Douglas will recommend some level of containerization or unitization, but the economics of closed container versus pallet needs further study in the light of air transport developments.

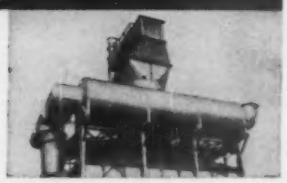
Though dedicated to the flow of goods, the terminal must be able to provide temporary storage. It must be designed to a balance between free movement and the risk of congestion. Greater capacity for assembly and loading areas and greater versatility of equipment and personnel avert congestion but are expensive unless detail engineering in the system is very good. Handling equipment of aircraft and terminals must be compatible despite



COMMERCIAL MODEL JEC-10



MILITARY MODEL JEM-8



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the variety of aircraft and terminals which will exist. Even the characteristics of foreign vehicles must be considered.

Makeup of a load must be controlled by the need to hold the center of gravity of the airplane within design limits. Procedures are needed to reconcile this necessity with item priorities and the order in which cargo will be off-loaded if there are two or more stops on the route.

This can be done by preassembly of the cargo or by analog simulation. All cargo units should be in the proper order at the cargo dock or mobile loader when the airplane arrives.

Data processing techniques for 463L are being prepared by International Business Machines Corp. experts who are determining what documents and machinable records must be associated with freight items and how they must be processed for efficient loading and shipping operations, marking and labeling of freight to correspond with documentation, means of coping with schedule alterations after cargo is already en route, etc. The Project 463L team is designing a common-user document with the features of 25 documents now in use and would standardize it in the hope of reducing paper work.

Douglas officials believe packaging weight can be reduced by lowering environmental protection standards, since USAF has adopted a policy of maintaining smaller inventories and climi-

Mobile Aerodynamic Test Stand

Mobile test stand, developed by the Cornell Aeronautical Laboratory, Buffalo, N. Y., obtains aerodynamic data in rotorcraft and ducted fan experiments. A balance system atop the support tower measures lift, drag and side forces, and yawing, pitching and rolling moments at speeds to 60 mph. The platform supports full-scale prototypes or models having gross weights to 3,000 lb. and rotor diameters to 17 ft. Height is adjustable from 40 in. to 10 ft. to test rotors both in and out of ground effect. Telemetered data is received by a separate vehicle.

Baggage Compartment Panels for Convair 880

White rubber baggage compartment panels, designed for the Convair 880 jet transport, isolate baggage compartments from other sections but allow accessibility for maintenance and inspection. Panels were designed by B. F. Goodrich Aviation Products, Akron.

nating long-term cargo storage.

Douglas analysts have found that if ground handling time of a large transport can be reduced from 6 hr. to 1 hr., aircraft utilization will double with a saving of $1,260 per trip. Better methods of handling cargo inside the airplane offer one way to cut the time and cost of ground operations. The job would be eased considerably by reducing the amount of friction which must be overcome to move cargo pallets the length of the airplane. Roller conveyor sections are being used and represent a considerable improvement over hand truck and manual methods, but Douglas is experimenting with a method which seems even more promising.

It involves the creation of providing an air cushion under specially-constructed pallets by pumping compressed air through floor vents. The company has named the development "Glide-Aire." To move a 3 ft. x 3 ft. pallet with an 1,125 lb. load on a flat, solid floor requires a force of 450 lb. Moving it along roller conveyors requires only 14 lb. and Douglas claims that only 4 lb. is needed with "Glide-Aire." The problem of getting cargo off the conveyor and getting the conveyor out of the airplane is eliminated. When cargo is in position, the air manifold can be turned off and cargo tied down in place. The floor vents are closed by ball valves which are opened by the pressure of the pallet. As the pallet moves off each ball, the valve closes to minimize loss of air.

Air manifold pressures and flow rates are not high. For the 3 ft. x 3 ft. pallet bearing a load of 1,125 lb., flow rate is 230 lb. per hr. at 10 psi. It can be supplied by a 6.5 hp. blower compressor. Air flow varies directly with the perimeter of the pallet. The "Glide-Aire" technique also could be used in terminals, loading docks, truck beds, etc. In some cases it has been found feasible to pump air through the pallet rather than through the floor. Either way, the air cushion technique can be used with side loading or end loading aircraft.

Cargo data processing system already operational at some MATS terminals will be fitted into the broader Project 463L. In line with the evolutionary philosophy adopted for the project by USAF, 463L will make the best possible use of existing equipment in its present form or with modifications. This will include such items as conveyor sections, fork lifts, trailers, winches, hoists, etc. The tools used in the system must be able to load any military cargo plane designed in the future or now in use.

Among the modifications of existing equipment being recommended for 463L is a reduction in the mast height of the 1,500 lb. fork lift to enable it to maneuver under the belly of a C-124 and the aft door jamb of the C-133 while carrying a loaded pallet.

certain.

MAJOR MERGER IN SWITCH INDUSTRY

Controls Company of America Merges Hetherington Div. With Electrosnap Corp. to form New Control Switch Division.

One of the precision switch industry's most complete product lines has come into existence with the announcement by Louis Putze, President of Controls Company of America, Schiller Park, Ill., that its subsidiary Hetherington, Inc., has been merged with Electrosnap Corporation, Chicago. The Electrosnap organization was recently merged with Controls Company of America

"This merger is important to switch users", Mr. Putze stated because it co[mbines]

WHAT'S IN IT FOR YOU?

You may now select from the industry's most versatile and complete line of precision snap-action switches, indicator lights, push-button switches, toggle switches, Switchlites, and environment-free limit switches. You can now make broader product groupings for greater quantity discounts. With this new single source, you will now deal with just one sales engineer for all your switch needs.

Three plant locations—Folcroft, Pa., Chicago, Ill., and El Segundo, Calif.—will provide regional engineering and manufacturing facilities to speed delivery and service.

Local sales offices with factory-trained personnel have been set up to provide on-the-spot application engineering in all major markets. An expanded nation-wide distributor organization will assure you of immediate delivery from local sources.

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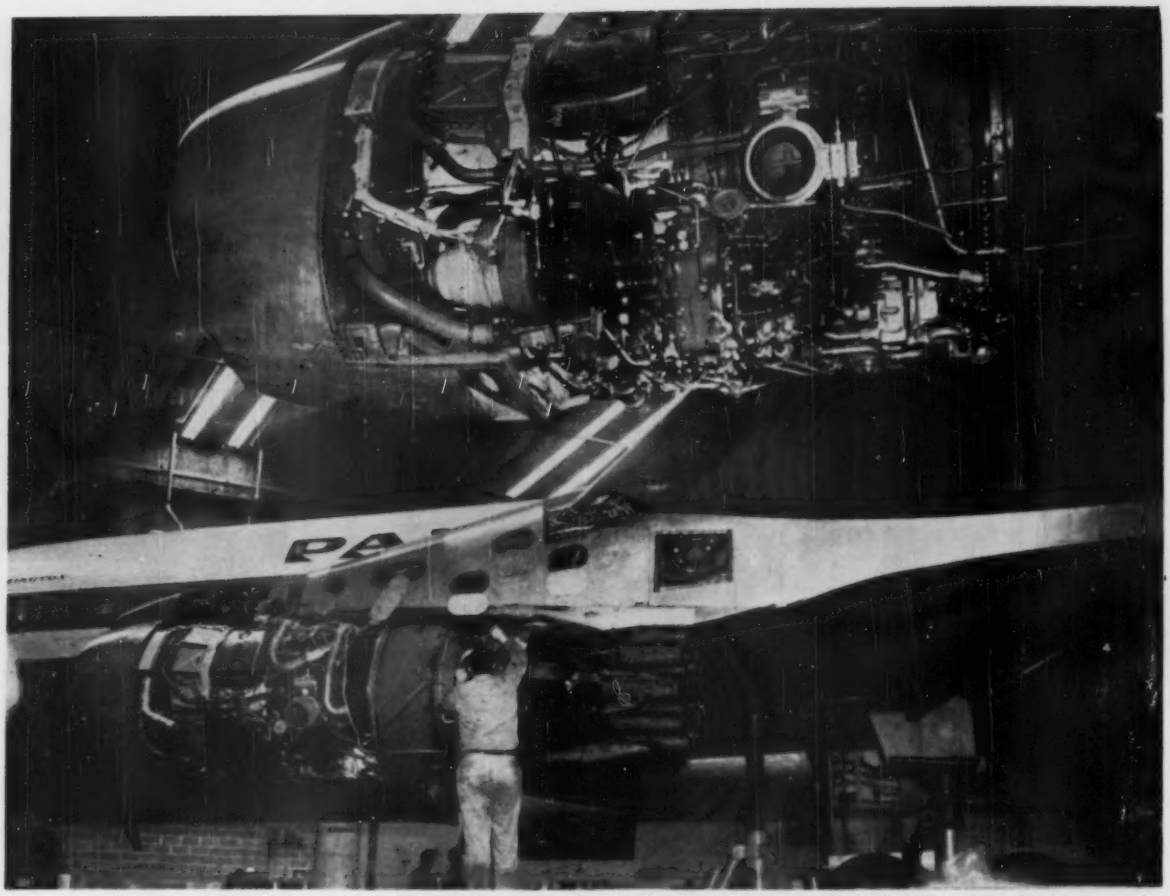
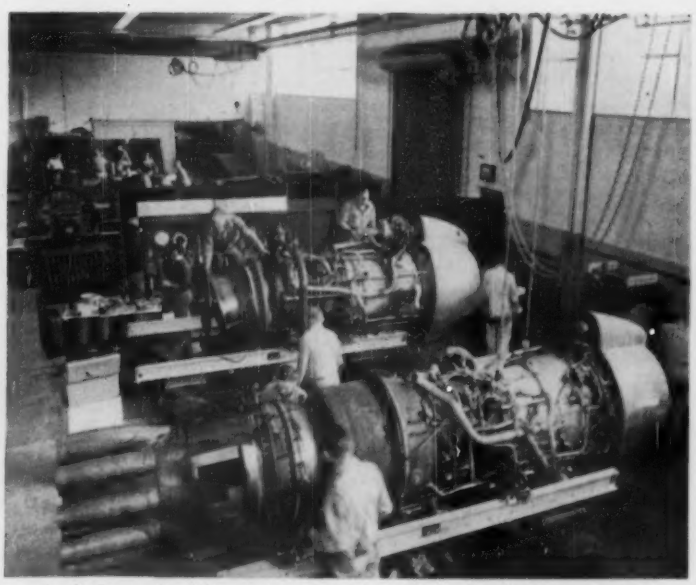


Engines of Pan American World Airways' Boeing 707 are given a periodic check at the carrier's $6 million Idlewild Airport maintenance base at which the airline currently is overhauling six Pratt & Whitney JT4 turbojets each week. Carrier temporarily discontinued overhaul of JT3 engines at Idlewild to gain initial efficiency.

PanAm, TWA Jet Maintenance Programs Grow



Engine crane (left) lifts turbojet from truck bed en route to overhaul shop. At right, mechanics conduct hot section inspection of JT3 (foreground) and JT4 engines. First engine overhaul began on Oct. 28, 1959. Carrier eventually will overhaul turbojets of Panagra, a Pan American affiliate, at the Idlewild shop.

Series of jet engine components (left) moves along chemical cleaning line of overhaul shop. Cylindrical item in foreground is a nozzle case costing more than $15,000. High angle view of plating vat area is at right.

Technicians (left) check balance of blades on newly overhauled turbine. Mechanics at right are installing fuel manifolds. Overhaul of JT3 engines at Idlewild will recommence in September. By December, Pan American hopes to be overhauling 60 engines per month.

Trans World Airlines 707 gets a bath in carrier's huge maintenance base at Mid-Continent International Airport, Kansas City, Mo. Ground school training also is carried out here (AW July 13, 1959, p. 46).

BIG PAYLOAD BIGGER STILL!

VANGUARD PAYLOAD UP BY 8,000 LBS. —Landing weight up by 9,500 pounds			
	Original specification	New specification (Standard Specs.)	Increase
Gross Take-off weight	141,000 lb	146,500 lb	5,500 lb
Max. landing weight	121,000 lb	130,500 lb	9,500 lb
Max. 'zero fuel' weight	112,500 lb	122,500 lb	10,000 lb
Max. payload	29,000 lb	37,000 lb	8,000 lb

■ The VANGUARD's payload has been boosted to 37,000 lbs. before entering scheduled service—8,000 money-making pounds better than advertised. This still leaves 1,600 lbs. in hand for even more development, equipment changes, or for customers' special needs.

■ Ten years experience has made the VANGUARD something unique in aviation history—a plane with a dual personality. Carrying 139 passengers and 9,000 lbs. of freight, the VANGUARD can turn around and make a handsome profit as a freighter, even when only 30% of the seats are sold. Two huge cargo holds provide three times the freight capacity of its closest rival, and freight handling was never easier with over four feet of working height and doors more than five feet wide.

MEMBER COMPANY OF BRITISH AIRCRAFT CORPORATION

■ And the VANGUARD is fast. Recent route proving trials all over Europe have shown the VANGUARD to be faster than competitive jets on short hauls and only a matter of minutes slower on medium hauls of 1,000 miles or more.

■ Yet the difference in operating costs is startling — to say nothing of the VANGUARD's operating flexibility which means built-in reliability of schedule.

■ The VANGUARD's direct costs are as low as 1 cent a seat mile at 900 miles, and 1¼ cents at 300 miles.

■ And, on top of this, there is now the income from 4½ tons of cargo which can still be carried even at 100% passenger loads.

■ The VANGUARD can now carry 139 economy-class passengers *plus* over 9,000 lbs. freight. Without intermediate refuelling, 100-passenger payloads can be carried over such important consecutive sectors as New York — Detroit — Chicago — St. Louis.

■ Operators with profit in mind and air travel for all in view, will find the VANGUARD is more attractive than ever.

■ For further details and a cost analysis based on your operations, contact Christopher Clarkson, U.S. Representative, 10 Rockefeller Plaza, New York 20, N.Y.

World's only 2nd generation jet-age airliner!

Vanguard benefits greatly from the more than 2 million hours of worldwide in-the-air experience of 400 Viscounts . . . and there is no substitute for experience!

VICKERS

VANGUARD

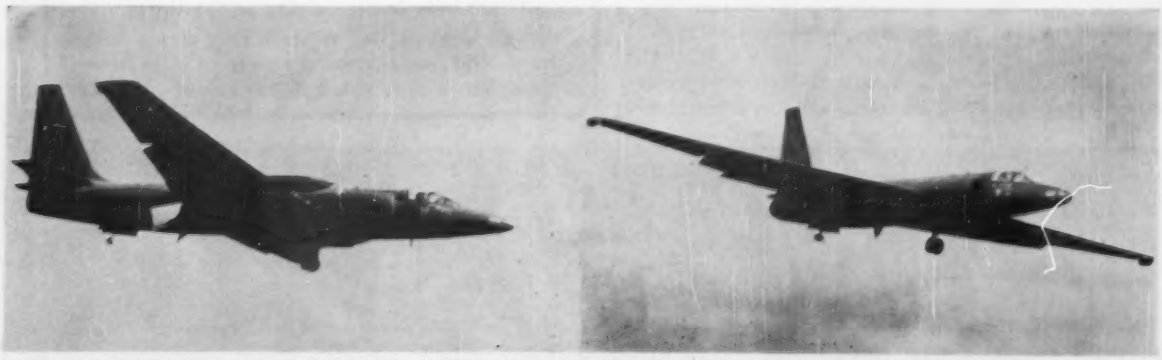
POWERED BY FOUR ROLLS-ROYCE TYNE ENGINES • VICKERS-ARMSTRONGS (AIRCRAFT) LTD. WEYBRIDGE ENGLAND

Radiation sniffer forward of the main gear and a ventral fin behind it are visible on this Lockheed U-2 in Japan.

Lockheed U-2 Research Aircraft Based in Japan

Several versions of the Lockheed U-2 research aircraft used by National Aeronautics and Space Administration and other government agencies for high-altitude weather research, photo reconnaissance and radiation sampling studies are shown during landings at bases in Japan. Design objective of the U-2 was to achieve maximum altitude performance possible within the state of the art of the mid-1950s and little compromise was made with this goal. The U-2 can maintain level flight at much higher altitudes than current fighter aircraft which have set world records by zooming to peak altitudes for a moment only. This performance was obtained by using a sailplane-type wing, keeping structural weight and strength very low and by using a specially-designed high altitude version of the Pratt & Whitney J57 engine. Example of U-2 weight savings is the single main landing gear. Small jettisonable wheels keep wings level during takeoff roll.

Auxiliary fuel tanks are carried on the U-2 about halfway out on each wing.



Landings in the U-2 are made on the single-point main gear. Small tail wheel and wing tip skids are provided to prevent structural damage when the aircraft heels over at the end of its ground roll. Drag brakes are used to steepen the landing approach.

ICBM Guidance Techniques Compared

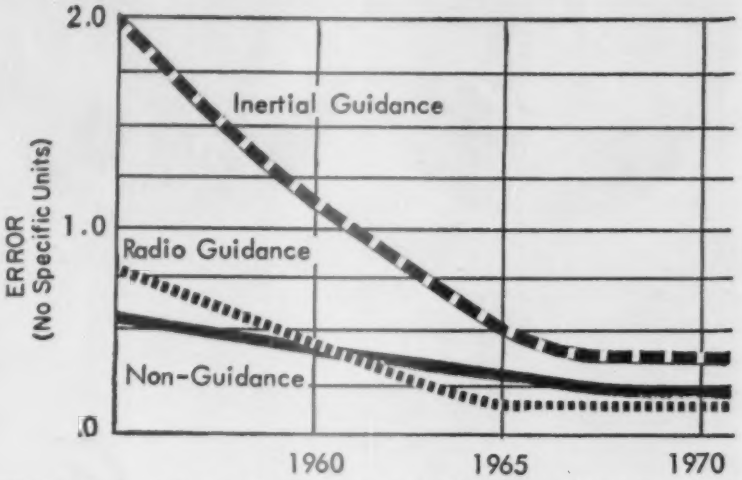
By Philip J. Klass

Cincinnati—Gross comparison of the relative accuracies and operational advantages of radio command and inertial guidance systems for intercontinental ballistic missiles was presented here by a representative of General Electric Co., the only firm that makes both types of guidance system. The occasion was the recent spring meeting here of the Institute of Radio Engineers and the American Rocket Society.

At present, the error in inertial guidance systems is approximately twice that of radio-command systems, but by 1965 inertial system accuracy is expected to match today's radio-command guidance accuracy, GE's R. C. Berendsen told the IRE-ARS conference. During the five year period, however, the error in radio guidance should also be cut by the same factor, he estimated.

Berendsen is manager of advanced projects for GE's Ordnance Department which is building Polaris inertial systems and tracking antennas for the Atlas radio-command system supplied by GE's Defense Systems Department.

Berendsen emphasized that his estimate of inertial system performance for an ICBM is extrapolated from data on intermediate range ballistic missiles inasmuch as there had not been any inertially guided ICBM missions at the time his report was prepared.



ERROR comparison between radio-command and inertial systems used for intercontinental ballistic missile guidance is shown above with relative magnitude of errors from other sources.

Non-Guidance Errors

Although the radio-command system has a pronounced edge in guidance accuracy, other sources of error in missile impact point must be considered and these in aggregate often equal or exceed errors due to guidance, Berendsen indicated.

Representative of such nonguidance system errors are the following:

• **Winds and drag uncertainty** during nose cone re-entry because of variations in atmospheric density, nose cone drag coefficient and/or winds aloft.

• **Gravity and geodetic uncertainty** arising because earth's exact shape and gravity field are not precisely known and because of inability to accurately correlate relative locations of sites in different parts of the globe (AW Apr. 25, p. 28). These uncertainties, now on the order of 0.2 mi., should be reduced by a factor of 2:1 or more using satellites for geodetic measurements.

• **Cutoff uncertainty,** particularly in sold-propellant motors, because of time lag between initiating cutoff and termination of thrust. Use of low-thrust vernier engines for final cutoff eases the problem.

• **Initial alignment inaccuracy** of missile before launch will result in error of almost 0.2 mi. for each 10 sec. of arc of azimuth misalignment, based upon a 5,500-mi. missile range.

• **Target location uncertainty** due to inadequate intelligence data may be largest of the errors, particularly in poorly mapped areas.

Although accuracy is an important consideration, it is only one of the several factors that must be weighed in selecting ICBM guidance systems, which explains the current switch from radio-command to inertial systems. Some of the factors that have swung the pendulum toward inertial guidance include:

• **Vulnerability:** Whereas an inertial system utilizes the same hardening that protects the missile itself, it is difficult to harden the antennas of radio-command guidance systems.

• **Mobility:** The large antenna structures and/or number of antennas required for radio-command systems make them less adaptable to mobile missile launching platforms, an important consideration in view of present trend toward mobility.

• **Salvo capability:** Whereas an inertial system imposes no limitations on the number of ICBMs that can be fired simultaneously, each radio-command installation can only handle one, or at most several, simultaneous launches. This is an important consideration, particularly for quick-reaction type missiles such as the Minuteman.

• **Flexibility:** Although early inertial systems were not designed to permit a rapid change of assigned target prior to launch, newer systems match the flexibility of radio-command guidance in this respect.

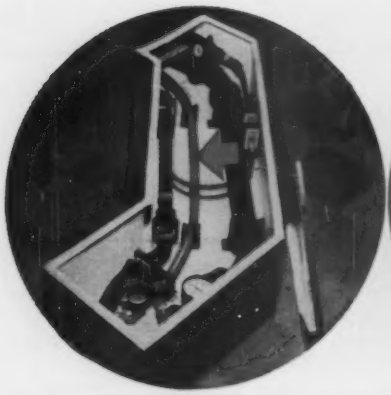
Radio-Command Advantages

Radio-command guidance has several advantages, however, in addition to its greater accuracy. These include the following:

• **Damage assessment:** Because the radio-command system tracks the ICBM to cutoff and could track it beyond this point, it can predict where the missile will strike and thus aid strategic planners in determining whether additional missiles should be fired at important targets. Inertially-guided ICBMs do not provide this feature, unless data is telemetered back from the missile during flight or a separate missile tracking facility is employed, and the latter would impose the same difficult problems of hardening as a radio-command system.

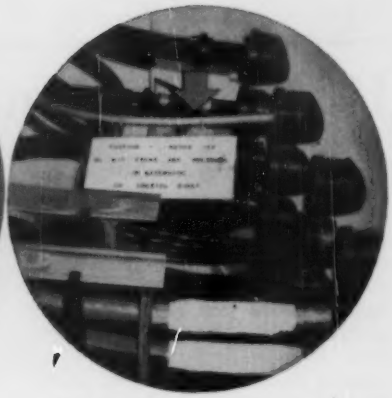
• **Reliability:** Because the missile-borne portion of a radio-command system is considerably less complex than inertial guidance and because greater redundancy can be used in ground-based portions of the system, radio-command system reliability logically can be expected to be superior. However, both may be at entirely acceptable levels.

The question of which of the two systems is the least costly cannot be



1. Within the control blockhouse, ⅞" 50 ohm Styroflex® cable starts its run to the Titan launch Complex 16 at Cape Canaveral . . .

2. Following along the domed wall of the concrete blockhouse inside a protective case . . .



3. To the conduit that carries the high frequency cable through the massive concrete wall.

Styroflex® Coaxial Cable

helps put the USAF Titan ICBM into space

The selection of Styroflex® air dielectric cable for use in the missile field was based on its superior electrical properties, uniformity, rugged physical qualities, long lengths that can be pulled up a tower without splicing and the elimination of radiation always present in braided coaxial cables. ■ Already proven in scores of applications, including broadcast, radar, missile tracking and tropospheric systems, Styroflex® cable has a long record of successes since its introduction in Europe in 1937. ■ Next time you have requirements for a high frequency cable with low attenuation and an extremely low inherent noise level, check the qualifications of Styroflex®.
Just write Phelps Dodge.

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4. Here, the Styroflex* cable from the blockhouse enters the lower deck of the Titan launch Complex 16.

5. Then begins to rise perpendicularly through the lower portion of the launch deck . . .

6. Climbs the side of the umbilical tower and helps send The Martin Company's Titan on a fast trip over the Atlantic Missile Test Range!

answered without an extensive study of the specific enemy targets and planned missile installations. For a widely dispersed missile like Minuteman, inertial systems may have the edge. But against a hardened enemy target where 25 or more lower-accuracy missiles may be required to assure the target destruction that could be accomplished by several higher-accuracy missiles, radio-command might have the advantage.

Space Probes

For space probe applications, Berendsen predicts that radio-command guidance will be the dominant technique used at least until larger boosters have been developed to permit the carrying of larger payloads. However, he does concede that for certain space missions, where the vehicle goes below the horizon before the guided portion of flight ends, radio-command systems encounter difficulties. For sophisticated space missions, such as planetary landings, midcourse guidance appears necessary to provide the required accuracy. This will be performed primarily by vehicle-borne optical guidance, probably employing an inertial system for stabilizing the optical trackers. Berendsen, therefore, sees radio-command and inertial systems as partners, rather than competitors, in space missions.

FILTER CENTER

▶ **Cooling Electronic Gear**—A study of cooling techniques to improve the effectiveness of ground-based Air Force electronic equipment has been initiated by Battelle Memorial Institute for Air Research and Development Command's Rome Air Development Center. As part of the one-year study, Battelle will look into high-speed centrifugal compressors, thermoelectric or Peltier cooling, and the Stirling and azeotropic cycles. The research organization will seek new cooling techniques and expects to confer with other organizations which are working on advanced cooling techniques.

▶ **Thermoelectric Cooling Program Grows**—Battelle Memorial Institute's joint industry-sponsored thermoelectric cooling research program which is seeking materials and techniques for Peltier cooling now numbers 28 companies including Bendix Aviation, Martin, Lockheed and United Aircraft.

▶ **Space Environmental Test Facility**—Need for extensive testing of airborne camera and reconnaissance systems is to be met with an environmental test laboratory next to Fairchild Camera & Instrument Corp.'s Defense Products' plant in Syosset, N. Y. The $1,400,000 facility will include a large altitude chamber which the company says will be capable of testing complete systems at altitudes up to one million feet and under temperatures between minus 100 and plus 200F and subjected to humidities up to 95%.

▶ **New Infrared Award Pending**—Bids for a Wright Air Development Division contract covering infrared lenses and new pressing techniques have been evaluated in Dayton and a $250,000 award is expected shortly.

▶ **Call For Globe-Com Papers**—Prospective authors for the Fourth Global Communications Symposium, Aug. 1-3, to be held at the Statler-Hilton Hotel in Washington, should submit abstracts by May 16. Mail abstracts to: Ralph L. Clark, c/o Office of Director of Defense Research and Engineering, The Pentagon, Washington 25, D. C.

▶ **Liquid-State Semiconductors**—Materials which retain semiconducting electronic properties in the liquid phase are attracting interest at Stanford Research Institute and General Electric Co.

Thermal conductivity, it is anticipated, may be lower in the liquid than in the solid state and this would boost the semiconductor's figure of merit—possibly make it useful in thermoelectric power generation at elevated temperatures. Results thus far are not conclusive.

▶**More Micro Module Money**—Army Signal Corps has awarded an $8 million contract to Radio Corp. of America for continued development of the Army-RCA Micro Module program. Combined with two previous contracts, this brings total invested by the Army in the Micro Module Program to $15,388,938.

▶**Solar Cell Efficiencies Climb**—Hoffman Electronics is now offering silicon solar cells with 13% minimum efficiency guaranteed. Cells with 14% efficiency are also in production and available on sample quantity basis. Only a few weeks ago, Nobel prize winner William Shockley told the American Physical Society that 50% improvement in solar batteries may be possible with better fabrication methods. Relative inefficiency of solar batteries, Shockley said, arises from unknown and uncontrolled recombination centers which absorb much of the current generated by sunlight.

▶**Micro-energy switch**—Philco has come up with a germanium switching transistor (max. 100C rating) which can operate at lower power levels than comparable devices, the company says, because of reduced internal capacities, made possible with its light etching techniques, and optimized static characteristics for low collector voltages and currents. First units to be offered will be packaged in TO-9 cases and will have specified gain bandwidth products greater than 125 mc. at one volt collector voltage and one mil collector current. Devices packaged in smaller TO-18 case will be out in design quantities in 60 days, and in smaller Philco sealed package (AW Apr. 11, p. 94) later this year.

▶**Nuvistor Tetrode** – Developmental models of RCA's nuvistor (AW Apr. 6, 1959, p. 59) small-signal tetrode are being made available on a limited sampling basis. The nuvistor tetrode RCA says is one third the size of conventional RF amplifier tetrodes. Beam power nuvistors are in development too, and are expected to be half the size of comparable beam power tubes.

▶**Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **General Electric Co.,** Light Military Electronics Department, will study and develop electrostatic latent image photography as part of a $900,000 award from Wright Air Development Division. Electrostatic latent image photography is described as a marriage of General Electric's thermoplastic recording techniques (AW Jan. 18 p. 87) and Air Force interest in using image forming characteristics of solid-state photosensitive layers. In this application, a photo-sensitive belt will be run through a conventional aerial camera and an electrostatic image will be made of the subject. This image will then be "frozen" by the thermoplastic method of RF heating, deformation by the charges, and freezing of the deformations by cooling.

• **Packard Bell Electronics Corp.** will deliver UHF radio sets to the Navy under a $1,250,000 contract from the Bureau of Naval Weapons.

• **General Electric,** Heavy Military Electronics Department, will produce high-power multi-beam search radars AN/FPS-7 under a $3,500,000 contract from Air Materiel Command in Rome.

• **Sperry Gyroscope Co.,** will continue its work on Polaris submarines with $8,817,022 contract for the design and manufacture of navigational systems and $10,868,269 for field engineering.

Reflecting the tremendous growth of Philco's computer business, this huge new ultra-modern plant is devoted exclusively to research, engineering, manufacturing and marketing of Philco Electronic Data Processing Systems. Comprising nearly a quarter-million square feet of floor space, it is headquarters for a staff of more than 1200 electronic scientists, engineers and skilled technicians. Fully-equipped with the most advanced research, testing and production facilities; manned by the leading scientific skills in the industry; it is the nation's outstanding computer plant. This new Computer Center will enable Philco to keep pace with the rapidly expanding demands of industry, government and science for the Philco 2000 Large-scale Data Processing System. You are cordially invited to visit the new Philco Computer Center and see the Philco 2000 in operation.

Computer engineers and scientists are invited to investigate the advancement opportunities at Philco.

PHILCO 2000 DATA PROCESSING SYSTEM
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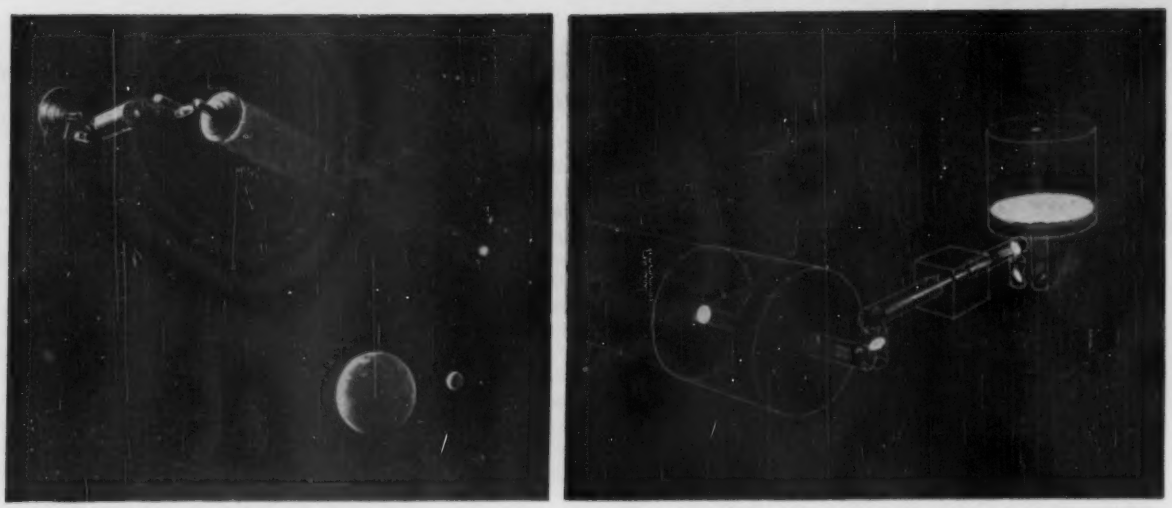


SOLAR COMMUNICATIONS SYSTEM transmitter collects solar radiation with antenna at left, feeds it through an intensity modulator and then reradiates coded solar energy on the right. Transmitter appears close up (right).

Space Signal System Uses Sun's Energy

Pasadena, Calif.—Details of an experimental optical space communications system which will use the sun's radiant energy as an intelligence carrier are being revealed here this week.

The system, known as solar communications system (SOCOM), is in development at Electro-Optical Systems, Inc., with Air Force backing under a $467,234 contract from the Wright Air Development Division (AW Jan. 4, p. 15).

Preliminary calculations for SOCOM have been completed and work on the breadboard model of the system is about to get under way.

Electro-Optical is one of a number of companies interested in the exploratory field of optical space communications (AW Dec. 14, p. 87 and Feb. 22, p. 63), which is attracting Air Force attention.

Earlier this year, the General Precision Laboratory Division of General Precision, Inc., was selected by Rome Air Development Center from a sizable group of bidders to study communications techniques in the near infrared and ultraviolet regions.

For lack of funds, WADD has temporarily delayed the award of another contract, which was expected earlier this year, for an infrared communications system.

Distinct Advantages

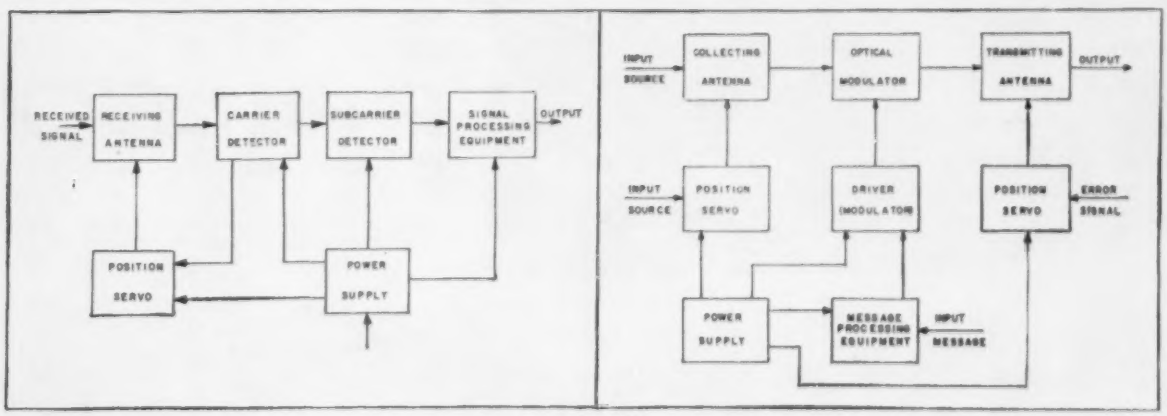
Optical wavelengths appear to offer several distinct advantages for communications in space where atmospheric absorption and scattering will be nil. Among these advantages are long distance transmission, relative invulnerability to jamming by a potential adversary, and the security guaranteed by the narrow beams of optical radiation. Besides these advantages, Electro-Optical engineers cite:

- **Reduced weight and power** of an optical system compared with a radio frequency system.
- **Superior reliability** promised by the absence of high-power electronic gear.
- **High signal-to-noise** ratios possible in space.

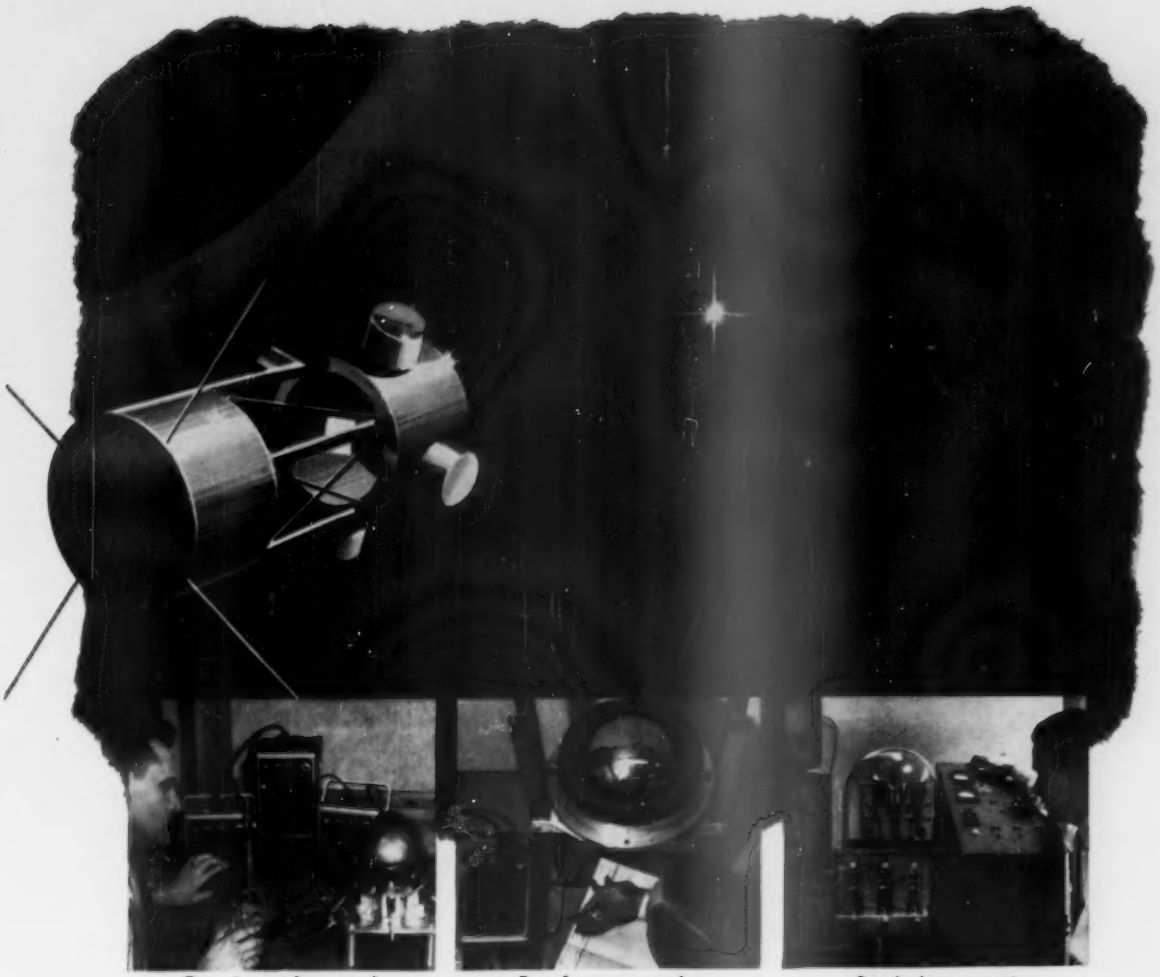
Exclusive of controls, the optical transmitter for SOCOM will weigh about 30 or 40 lb., and draw 10 to 15 watts.

These figures, the company says, are based on laboratory calculations for an experimental system which is somewhat more complex than a final unit. Signal-to-noise ratios of 10 are anticipated for systems capable of communicating at 10 million mi. and using antennas with one square meter areas and bandwidths of 10 cps. A factor of 10 boost in these ratios would be possible if the photocathode of the detector were cooled to reduce thermal emission or if large, lightweight optics were employed.

SOCOM may be used in a variety of



BLOCK DIAGRAMS of the transmitter (right) and receiver (left) for the solar communications system which is being developed by Electro-Optical Systems for the Air Force.



One element for control of all three axes

Free from gyroscopic cross-coupling

Bearingless support using electric fields

FREE WHEELING

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A single reaction sphere—electrically suspended—is the Bendix *free wheel* concept for space vehicle attitude control. Conceived to use the space environment to advantage, the *free wheel* concept eliminates the reliability problems of conventional reaction wheel bearings. Three stator windings placed in orthogonal planes are energized to generate control torques around any axis of the rotor (and any axis of the space vehicle by reaction).

Free from bearing vibration and gyroscopic cross-coupling, the *free wheel* provides a unique capability for precision attitude control of orbiting scientific and military observatories.

This project is part of the over-all Bendix space-systems development program which includes satellite communication, satellite navigation, radiation-resistant electronics, magnetohydrodynamics, plasma shock tubes, and infrared reconnaissance.

Opportunities are open to better engineers and scientists interested in participating in advanced space programs in an ideal scientific climate. Write today for complete information.

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MEMO TO ROBERT:

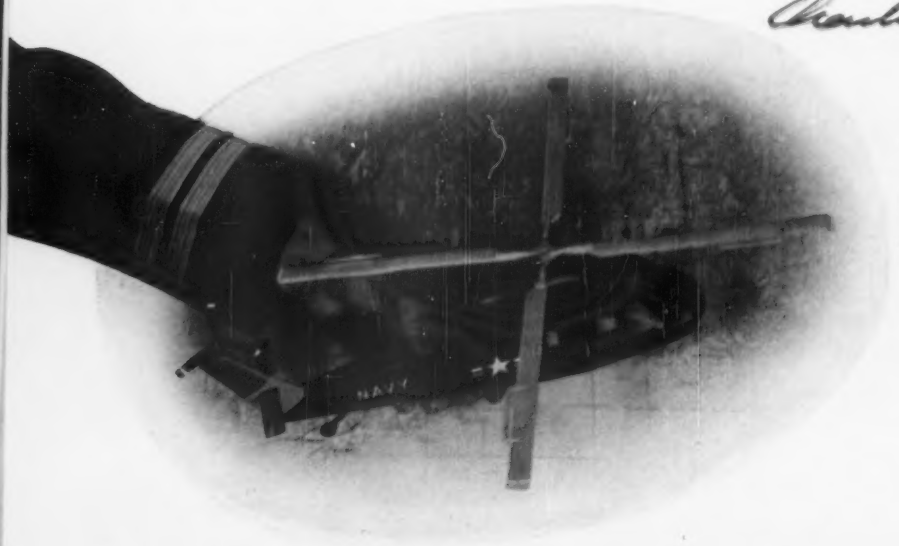
I am in receipt of your recent letter in which you say in part:

When I got the pictures that you sent me I was very happy and brought them to school with me and on my way home I had a fight with another kid I put books and the pictures on the ground and while I was fighting somebody took the pictures. I swear on the Bible that is the truth so could you please send me some more pictures of Kaman Helicopters.

Your new set of pictures is on the way. Robert, I hope that as you grow older and become a young man you will keep your interest in helicopters and aviation in general. When you and the boys of your generation take over the responsibility of running our great country, I hope you will find it strong and prosperous. Our National Defense effort right now is dedicated to that purpose, and with boys like you who are willing to fight for what is right, we know that our country will be in safe hands in the future.

Sincerely,

Charles H Kaman



**Facsimile of actual letter received

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space communication applications. Vehicle-to-vehicle, vehicle-to-space station, space station-to-vehicle or even vehicle-to-earth communications under favorable atmospheric conditions are all possibilities. Electro-Optical is suggesting a chain of SOCOM systems properly situated throughout the solar system and maintaining continuous contact with one another. Such an arrangement might also solve thorny acquisition problems posed by the use of extremely narrow beam systems.

In the SOCOM system, the sun's rays, which cover the spectrum from the far infrared to the near ultraviolet, are collected by a mirror antenna system and funneled through an intensity modulator for coding, and subsequently reradiated through a second mirror system toward a distant receiver. At the receiving end, the coded solar radiation is picked up by another mirror antenna, detected by a photo-multiplier, fed to signal processing equipment and finally read out.

Both transmitter mirror systems are Cassegrainian arrays (double mirrors with one focusing light back through a hole in the center of the first) which permit collection of solar radiation from any angle. Sun tracking needed to acquire the light source for the transmitter can be handled by radiation tracking transducers developed here by Electro-Optical (AW Sept. 21, p. 79). These solid-state transducers are said to be capable of resolving the angular position of a radiation source to better than 0.1 sec. of arc and silicon versions are sensitive from ½ micron in the visible region to 1.1 microns in the near infrared.

The second Cassegrainian array, which is effectively the transmitting antenna, acts as an optical universal joint enabling the transmitter to pick up carrier radiation from one direction and independently aim it in another direction. This transmitter antenna can supply 53 db. more gain than an isotropic source, according to Electro-Optical engineers.

The receiver antenna can either be a Cassegrainian system with the detector located behind the primary mirror or a parabolic collector with the detector mounted at the focus.

A number of different modulation schemes ranging from the Kerr, Farraday and Pockels effects to stress optics, ultrasonics and electromechanical modulators are reported under consideration. The final modulator will be capable of radiating away any energy absorbed from the beam, thus avoiding the ill effects of overheating.

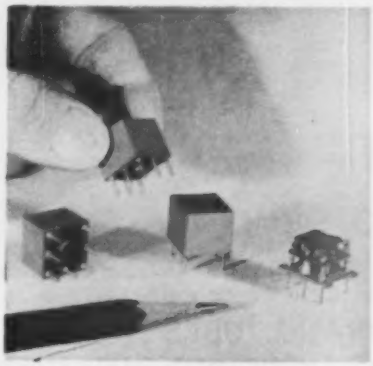
As for detectors, Electro-Optical engineers prefer photomultipliers because of their low internal noise, high quantum efficiency over the solar wavelengths, and noise-free amplification. The remainder of the signal-processing equipment will be conventional and fixed by whatever modulation technique is finally selected.

The company is proposing a "field test" of the SOCOM system in space within two years so that the concept and the equipment can be fully evaluated.

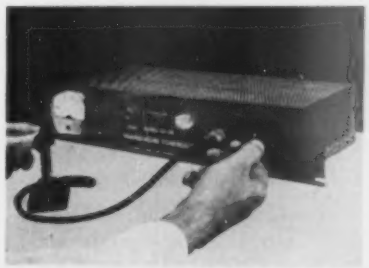
NEW AVIONIC PRODUCTS

Components & Devices

• **Shift register element** in epoxy-encapsulated package which contains a complete one-bit shift register circuit and occupies ⅛ cu. in. volume is available with pin terminations for printed circuit mounting. These elements, called



Microbits, operate from d.c. to 250 kc. at up to 100% duty cycle over −55 to 100C ranges. Elements require less than 150 mw. peak power to advance a signal state from stage to stage. Magnetics Research Co., Inc., 255 Grove St., White Plains, N. Y.



• **Infrared source,** Model PE 521-6, provides adjustable source of infrared radiation for calibrating the seeking head of infrared guided missiles and other infrared sensitive missiles in the 200 to 600C range when used with Model PE 521-5 temperature controller. Model measures 3 in. in length, 3½ in. high. Perkin-Elmer Corp., Norwalk, Conn.

• **Static inverter,** 90-watt, single-phase unit suitable for any application requiring high 400 cps. output, particularly

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MODEL 722 *

Fault Finder

USING REVOLUTIONARY NEW RADAR PRINCIPLE

The SF Model 722 Fault Finder presents a new and valuable approach to the solving of time-consuming cable fault problems. It has proven especially valuable in the aviation, broadcast and marine industries.

A true radar principle is used which obsoletes the use of the resistance capacitance method. With the radar principle, line condition is portrayed on a cathode-ray tube. It accurately defines the fault whether shorted, open or intermittent and indicates the distance from the instrument to the fault.

Model 722 is simple to operate and has a minimum of controls. An accuracy of 2% in ranging to a fault may be obtained.

SPECIFICATIONS

RANGE: 10 to 200 feet in cable with a constant of .66 — proportionately more or less in cable with a higher or lower constant.

MARKERS: Four markers appear when the "marker" switch is activated.

PULSE RATE: 2000 cycles per second.

PULSE AMPLITUDE: 350 Volts — .03 micro-seconds in duration.

WEIGHT: 12 lbs.

PRICE: $375.00 f.o.b. Factory, Seattle, Wash.

Contact Factory or Field Representative for complete literature or demonstration and early delivery date.

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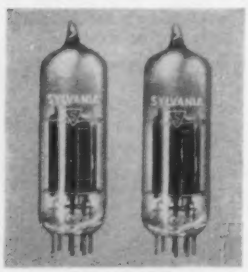
Gold Brand Tubes are disciplined to take impact shock tests of up to 750 g, fatigue tests for 96 hours at 2.5 g, and multiple life tests of 500 to 1000 hours. They undergo a multitude of stringent tests, including ability to withstand high degrees of vibration and thermal shock. Nothing is overlooked to give you the most reliable tube product available for the specialized needs of today's aircraft.



Specify Gold Brand Tubes—rugged, reliable AND readily available from your local Sylvania Industrial Tube Distributor. Ask him for the "Gold Brand Reliable Tubes" booklet. Or, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 103-5, 1100 Main Street, Buffalo, N. Y.

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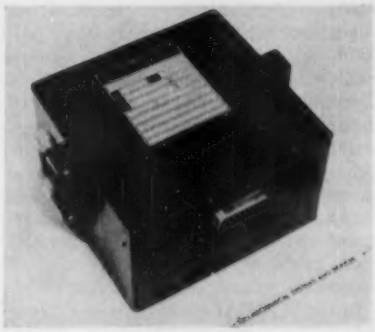
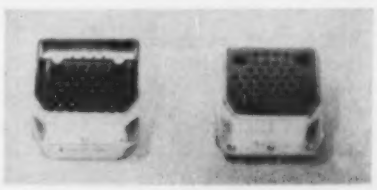
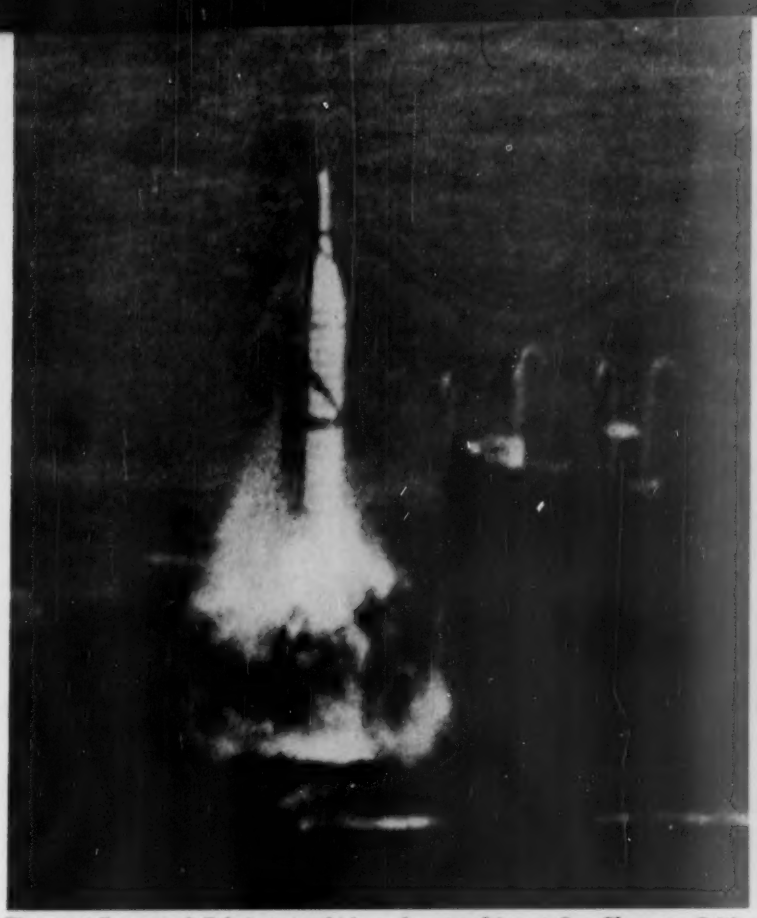


ideal for delivering power to mechanical telemetering commutators or to gyros. Inverter weighs 3¼ lb., will perform over −65F to 180F range, has 70% efficiency, holds output frequency to within 3% and has ±2% no-load to full-load voltage regulation. Kinetics Corp., 410 South Cedros, Solana Beach, Calif.

• **Rate gyro,** Type M-100, provides constant damping without heaters and is said to do the work of a standard 2-lb. gyro in many applications. Gyro weighs 6 oz., is 2⅞ in. long and provides constant damping from −65F to plus 250F. Minneapolis-Honeywell Regulator Co., 40 Life St., Boston 35, Mass.

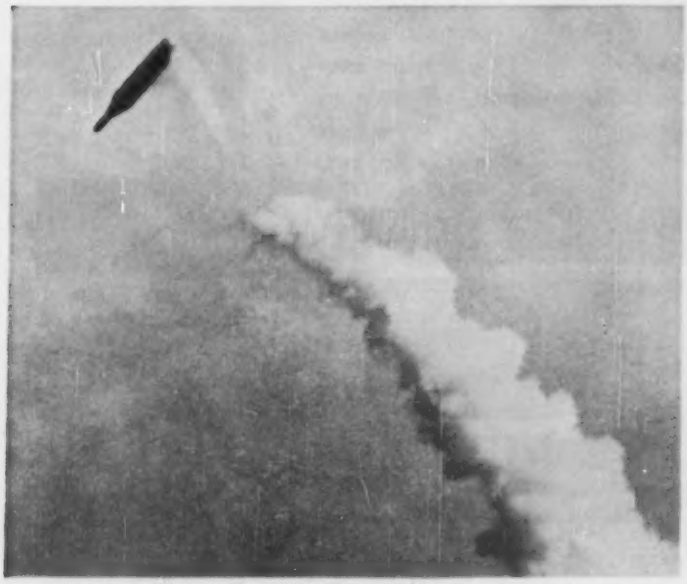


• **Connectors, 500L series,** are 48 and 63 contact rack-and-panel connectors. The 63 contact connector has 59 size 20 snap-in contacts and four size 16 contacts while the 48 contact connector has 43 size 20 and five size 16 snap-in contacts and two standard RG58/U coaxial contacts. Snap-in contacts are designed to meet MIL-C-26636 specs. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.



First partially-powered Polaris test vehicle underwater firing at San Clemente, Calif., (AW Mar. 14, p. 37) was considered successful when Aerojet first stage engine ignited in flight, pushing the vehicle 2,000 ft. high and about a half mile in the 5 sec. powered phase. Second stage engine remained inert and most propellant in the first stage also was inert, leaving enough for the 5 sec. run. Missile was fired from underwater submarine system identical to one of the 16 tubes installed on the USS George Washington nuclear submarine.

Polaris Makes First Underwater-to-Ignition Flight



Polaris begins drop to the sea at 2,000 ft. apex as first stage engine enters the burnout phase. Impact is shown at right; total flight lasted about 20 sec.; system was 100 ft. below surface. Launch was conducted by Naval Ordnance Test Station and Lockheed Missiles and Space Division. Vehicle carried a three-link telemetry system which transmitted performance data on 36 channels to the control blockhouse on shore.

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Silky smooth—and so invitingly comfortable. But routine for Eastern Air Lines' Lockheed Electras as they wing their way to northern cities and southern resort areas. Eastern engineers always insist on performance and reliability, too. The mighty Allison Turboprop engines in Eastern's Electra fleet are sparked by AC Jet ACniters. They deliver the kind of performance and reliability that goes with AC's long series of pioneering firsts in the field of aircraft spark plugs—and over 15 years of experience in the jet ignition field.

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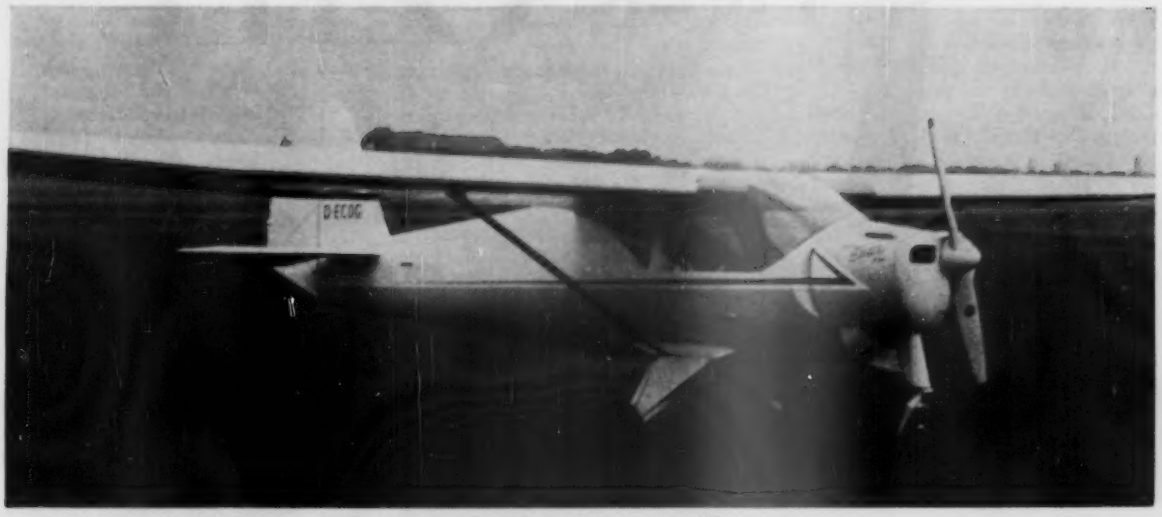

ELSTER-B two-seat sport lightplane is made of wood and can be used for towing gliders.

Putzer Develops New Elster Version

Bonn, Germany—First six models of the Elster-B Magpie two-seat, single-engine sport plane, latest version of the Pützer Elster series, have been delivered to sport groups of the German Luftwaffe.

The plane, manufactured by Alfons Pützer K.G. Flugzeugbau at Bonn, was introduced about two and one-half years ago. German Air Ministry certification of the Elster-B was granted last August.

The braced high-wing, all-wood monoplane has been designed for sport and business flying.

In addition, because of its slow-speed flight characteristics, it is suitable for towing gliders as well as for pilot instruction in the technique for towing gliders.

The Elster is a development of the Motorraab, a powered version of the standard Pützer Doppelraab sailplane. Pützer produced the Motorraab by fitting a 30 hp. modified Volkswagen automobile engine and a tricycle landing gear to the glider's airframe.

COCKPIT is fitted with dual controls. Plexiglas windows afford good visibility.

Elster Powerplant

A 65 hp. Porsche 678/1 engine powered the Elster prototype. Powerplant of the Elster-B is a Continental C90-12F engine rated at 95 hp. at 2,650 rpm.

It drives a wooden, two-blade, fixed-pitch airscrew made by Hoffmann of Rosenheim, Germany.

With a gross weight of 1,540 lb., power loading is 16.2 lb./hp. and wing loading 7.95 lb./sq.ft.

The single-spar wings have a streamlined metal bracing strut on each side and the internal structure is built on a leading-edge torsion box.

Fuselage is a plywood monocoque structure. The enclosed cabin is soundproofed and fitted with dual controls. It provides accommodation for the pilot and one passenger side-by-side. The upward-hinged doors—one on either side—allow easy entrance or exit. Plexiglas windows afford a good all-round view and a large baggage compartment behind the passenger seats also is provided.

The wire-braced, monoplane type tail unit has a stabilizer made of plywood. Elevator is braced by steel-tube, the

Elster-B Specifications

Weights:	
Empty weight	1,012 lb.
Gross weight	1,540 lb.
Dimensions:	
Span	43.36 ft.
Length	23.28 ft.
Height	8.20 ft.
Wing data:	
Wing area	188 sq.ft.
Wing loading	8.2 psf.
Power loading	16.2 lb./hp.

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Five passengers, plus baggage, plus full IFR equipment, plus 144 gallons of fuel with a range of more than 1,000 miles at over-200 mph cruise – that's the utility you get in the Piper Aztec . . . largest, fastest, newest airplane to join the Piper fleet of business airplanes. Already selected by the U.S. Navy to meet its requirements for an economical utility transport aircraft, the Aztec is meeting enthusiastic acceptance by professional pilots, for its superb all-around performance and load carrying ability – and by private owners, for its extreme ease of handling and low cost. Priced at only $49,500, completely equipped* except for radio, the Aztec is the only over-200 mph twin-engine airplane selling for under $50,000, yet it carries a bigger load, does a better job than any other aircraft in its class. Before you settle on any twin-engine airplane, be sure to evaluate the Aztec. It offers a complete new dimension in twin-engine utility at practical cost. See your Piper dealer or write for Aztec brochure, Dept. 5-W.

*Standard Aztec equipment includes full instrumentation, dual generators, dual vacuum, heated pitot, rotating beacon and 144 gallons of fuel – nothing to add but radio. Autoflite Aztec, complete with dual Omni, dual transmitters, ADF, Piper AutoControl automatic flight system priced at $54,105.

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Elster-B Performance

Cruising speed	93 mph.
Maximum speed	103 mph.
Limit speed	112 mph.
Stalling speed	46 mph.
Takeoff distance over a 49 ft. obstruction and at 1,540 lb. gross weight	687 ft.
Landing distance (approximately)	623 ft.
Speed for best rate of climb and descent	56 mph.
Best rate of climb	720 ft./min.
Ceiling	16,400 ft.
Range at best cruising speed	280 mi.
Fuel	16.9 gal.

rudder and fin is of wooden construction.

Nose wheel of the rigid, tricycle-type landing gear is controlled from the pilot's seat and can be locked for takeoff and landing.

The simple design of the Elster, its economic operation and easy maintenance are all features aimed at making it suitable for do-it-yourself kits for amateur construction.

Standard Equipment

Standard equipment includes the airspeed indicator, altimeter, variometer, compass, tachometer, oil pressure, oil temperature and fuel gages, two pairs of seat-belts, one first-aid kit and a set of mechanic's tools.

When used for towing gliders, standard equipment includes a cylinder head temperature gauge, a glider-hook attachment and a rear view mirror.

Provision is made for radio equipment as optional equipment, but may only be fitted on condition that the manufacturer supervises the installation.

Price of the standard Elster with a 65 hp. Porsche engine is about $5,744. The Elster-B model with a 95 hp. Continental C90-12F engine costs approximately $6,232.

PRIVATE LINES

Four-engine Lockheed JetStar has been sold by Lockheed Aircraft Corp. to the Essen, Germany, firm of Fried.-Krupp, manufacturers of ships, locomotives, steel structures and other products. Krupp will take delivery of the plane, powered by four Pratt & Whitney JT12 turbojets of 3,000-lb. thrust each, in March, 1961. Executive jet will carry eight passengers and two crewmen. Sale marks the entry of the JetStar on the European continent.

Among corporate customers who have ordered 11 Allison turboprop conversions of the Convairliner are Ford Motor Co., Union Oil Co., Humble Oil Co., Allison and AC Spark Plug Divisions of General Motors. Conversion has been approved by Federal Aviation Agency under the supplemental type certification SA 4-1100 at maximum gross takeoff weight of 53,200 lb. at a minimum field length of 4,180 ft., compared with FAA-certificated takeoff weight of 47,000 lb. on a 4,650-ft. minimum runway for the piston-powered Convair 340.

Heliport design department has been set up by Rader and Associates, Miami, Fla., consulting firm. Earle M. Rader said the group will make a continuing study of VTOL design developments, as well as municipal and federal regulations, to develop a criteria for ideal ground conditions.

Aeroflot has reduced rates for acrial spraying, dusting and seeding up to 25% to promote use of its agricultural aviation services and increase the utilization of its fleet. New tariffs include schedule of charges for helicopters, which Aeroflot reports will be "widely introduced into agricultural work this year." Last year Russian agricultural aircraft processed more than 49 million acres, some 5 million acres more than during the previous year.

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. . . most shop inspectors would accept it as genuine. It looks the same. And it carries the anchor stamp of a famous manufacturer. In fact, we are fairly certain that parts similar to this one are used in engines flying today.

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Airwork sells and uses only genuine Pratt & Whitney Aircraft parts . . . and inspects the parts of your incoming engine to make sure somebody hasn't short changed you with a bogus part on maintenance . . . or a previous overhaul.

The difference between a genuine part, with all the stamina and service-ability the manufacturer can develop—and a dangerous bogus part is sometimes so hard to spot that only a distributor with close factory connections has the training to spot the true from the false.

That's one more good reason to have your engines overhauled by Airwork. You are sure of getting genuine parts, careful craftsmanship and the pains-taking protection of our eagle-eyed Airwork inspectors. Call or write our nearest branch office for details.

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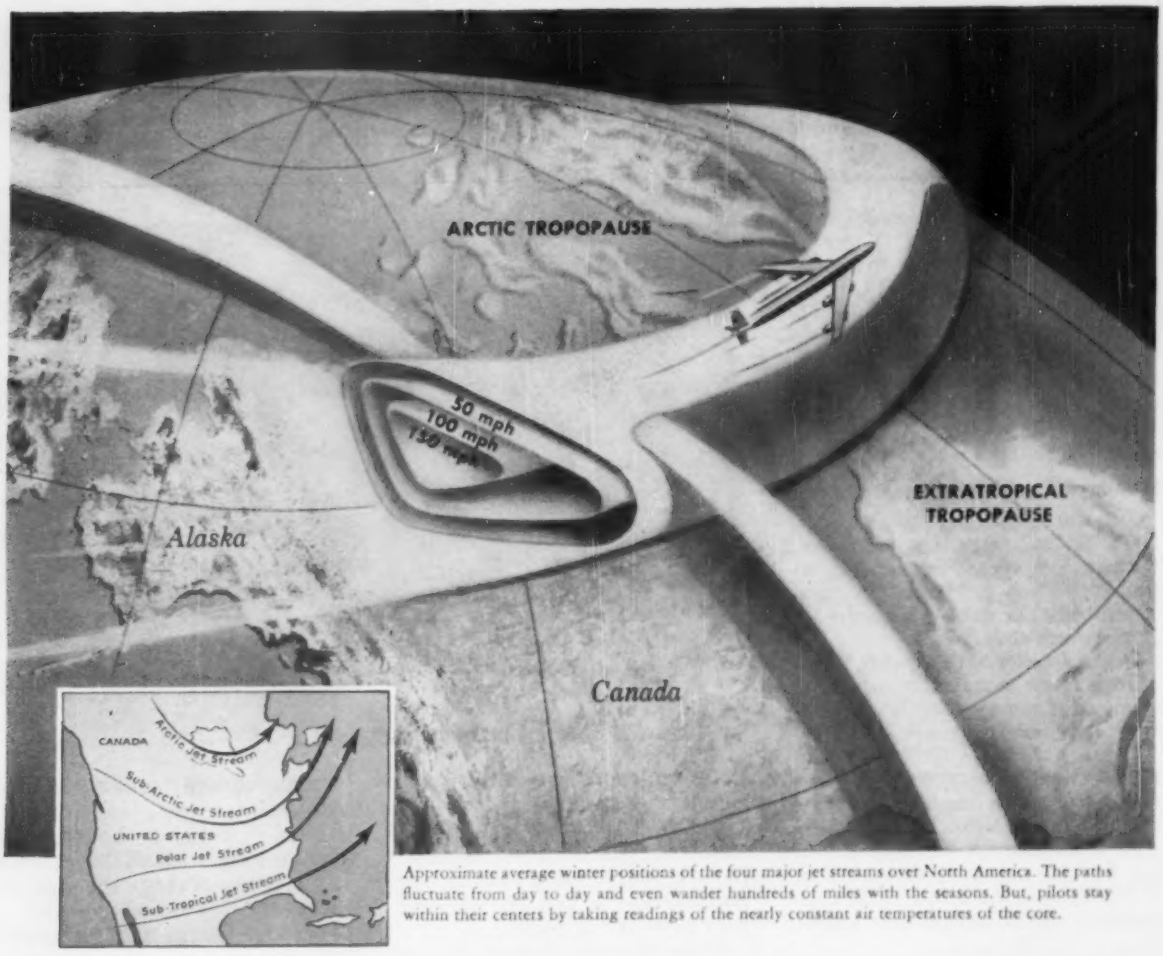
High Velocity Winds Speed Long-Range Jet Flights



Approximate average winter positions of the four major jet streams over North America. The paths fluctuate from day to day and even wander hundreds of miles with the seasons. But, pilots stay within their centers by taking readings of the nearly constant air temperatures of the core.

TODAY, jets can boost their ground speeds upwards of 150 miles an hour with the help of the jet streams—giant rivers of westerly winds, flowing at hurricane speeds, 2 to 8 miles above the Northern and Southern Hemispheres.

Jet streams are basically a result of the marked temperature variations existing between the tropical, extratropical and polar tropopauses, and are usually found coursing along the broad areas where one tropopause overlaps another. Shaped much like a flattened tube, the streams are from 100 to 300 miles in width and from 2 to 5 miles deep. Wind speeds at the core are generally about 150 mph (though much greater velocities have been recorded) and diminish outward from the center.

* * *

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U. S. Business & Utility Aircraft Shipments

February 1960

Make and Model	No. of Units	Dollar Billings
Aero Design 500	1	$630,000
560E	2	
680E	5	
Beech Super 18	11	$3,943,000
Model 65 Queen Air	0	
Model 33 Debonair	23	
Model 35 Bonanza	38	
Model 50 Twin-Bonanza	9	
Model 95 Travel Air	13	
Callair A-6	1	$7,000
Cessna 150	30	$6,300,000
172	74	
175, Skylark	56	
180	33	
182, Skylane	82	
210	90	
310D	26	
Champion 7GC Traveler	4	$112,000
7FC Tri-Traveler	7	
7GC Sky-Trac	7	
7HC Dual	2	
Mooney Mk. 20	9	$104,000
Piper PA-18	23	$4,368,000
PA-18-A Super Cub	4	
PA-22 Tri-Pacer, Caribbean	58	
PA-23 Apache	8	
PA-23 Aztec	43	
PA-24 Comanche 180	34	
PA-24 Comanche 250	60	
PA-25 Pawnee	38	
Totals	909	$15,464,000

Note: Shipments in February, 1960, represented 104 aircraft over the number shipped in January and factory billings of more than $15.4 million compared with billings of $8,778,000 in January. Shipments in January, 1960, totaled 640 aircraft with net billings of $9,648,000 and in February, 1959, totaled 597 aircraft valued at $8,778,000, indicating that the industry this year has taken a good lead over early last year.

Swiss Pilatus Porter aircraft "Yeti" now supporting the Swiss Dhaulagiri Expedition in the Himalayas (AW Apr. 4, p. 127) has dropped supplies totaling 5,500 lb. in 10 successive flights at an altitude of 17,056 ft. Early this month Swiss pilot Ernst Saxer landed the Porter on the 18,696-ft.-high Nordcol glacier on a 656-ft. snow strip, believed to be the highest mountain landing ever achieved by any aircraft. On a later mission, Saxer developed engine trouble and made an emergency landing in rough terrain. Saxer and three passengers aboard at the time escaped injury and the plane was only slightly damaged.

Raymond G. Largent, 57, Cessna Aircraft secretary and controller, died Apr. 14 at Wichita, Kan. He was elected to the secretaryship in 1952.

First Photo of Prototype Rotorwing Autogyro

Rotor blades of Rotorwing Aircraft's two-place autogyro (AW Apr. 18, p. 146) are made of cedar and mahogany with a steel spar. Aircraft can be towed on a special trailer. Powerplant is a Continental C85 four-cylinder engine, producing 85 hp.

AIRESEARCH POSITIONING CONTROL SYSTEMS

One of the many types of high speed positioning control systems produced by AiResearch, the system above amplifies electric signals from an inertial guidance source and adjusts the control surfaces of the missile or drone to maintain a predetermined course.

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Rising Costs Delay Jet Transport Profits

By William H. Gregory

Manufacturers of U.S. turbine transports are hoping 1960 will finally see these airplanes begin to make some return on investment, but factors of higher than projected costs and competitive pressures still make the process a long and uncertain one.

Boeing late last year reached the stage where the sales price of Boeing 707 was beginning to exceed what it cost to build. But Boeing's President William M. Allen pointed out that reaching an over-all breakeven point is moving farther down scale. Partly this is because of the prospect of new, unforeseen research and development costs to meet performance competition.

Douglas hopes to begin delivering "profit" airplanes before the first half of this year but unexpected research and development costs are adding a measure of uncertainty. Other manufacturers are facing similar problems.

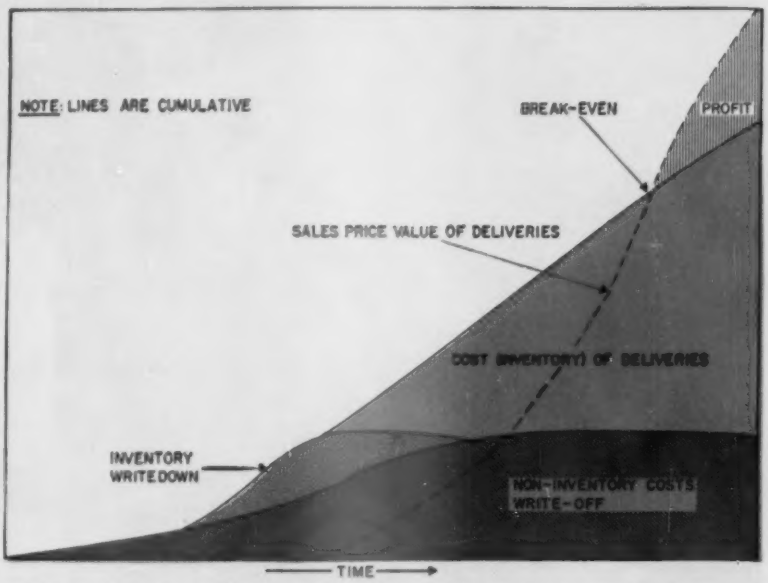
Substantial costs were expected when manufacturers decided to go ahead with their projects, but these elements tended to confound the estimates:

• **Versionitis.** Unlike a military program, where production airplanes generally are standard, manufacturers found airlines wanted a great many detail variations in cabin configuration, cockpit layout, insulation, interior trim etc. As a result learning curves—and thus production costs—tended to fall slower than military programs indicated.

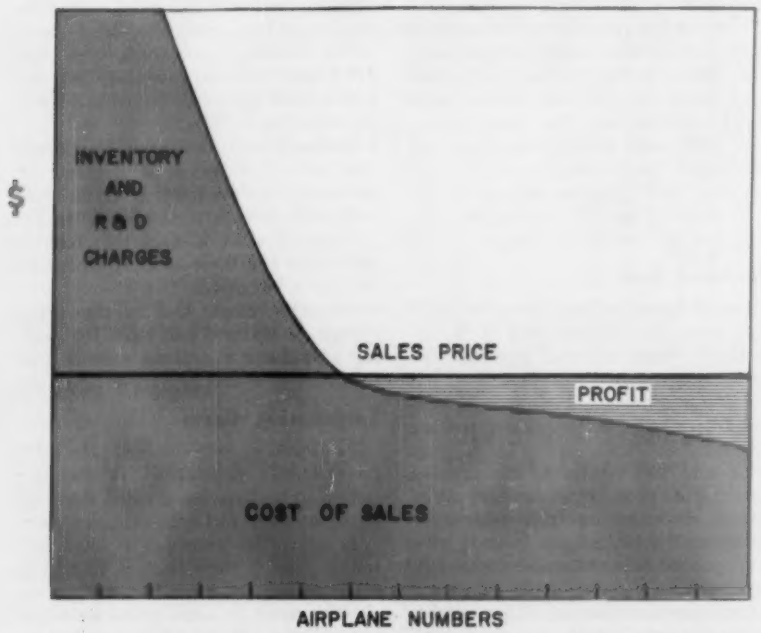
• **Competitive demands.** With four U.S. manufacturers—Boeing, Douglas, Lockheed and Convair—competing more or less directly for domestic trunk line and international orders and against foreign manufacturers also, pressure on prices became strong. This did not necessarily mean price shaving. It may have resulted in not fully pricing variations from standard, or in accepting used aircraft in trade-ins, or in carrrying part of the financing for some customers. There have been two rounds of "basic airplane" price increases, the latest revealed last week by Boeing (4-6%) and Douglas (5%). Convair raised 880 prices $200,000 a year ago, now is quoting the 880 at $3.6-$3.8 million, the 600 at $4.3 million. Boeing and Douglas run $5-$6 million. Convair, which has been stressing its lower prices, plans no increase now.

• **The development problems.** These ranged from producing reversers and suppressors, estimated by some sources as costing Boeing and Douglas at least $15 million each, to fixes such as that Lockheed made in changing the angle of attack of the Electra engine nacelles to reduce cabin noise and vibration. Douglas is making various modifications to the DC-8, such as leading edge slots on the wing and wingtip extensions.

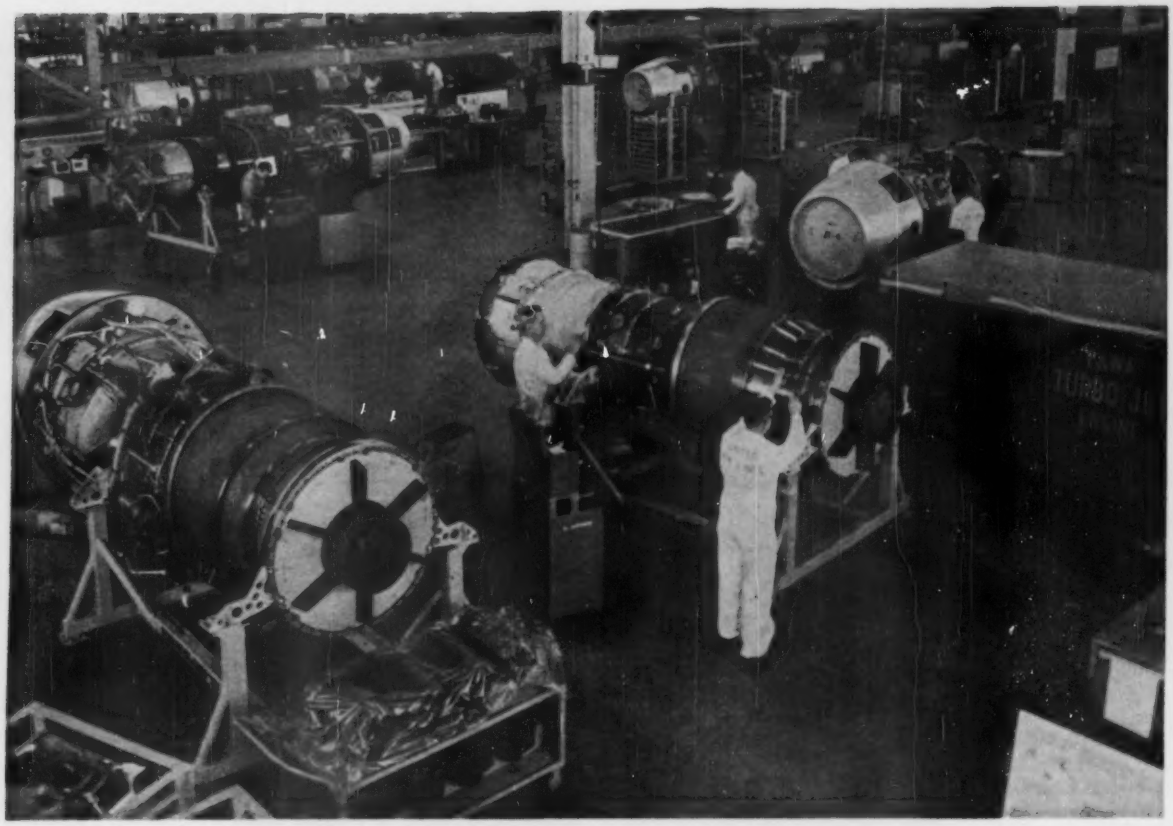
• **Rate of orders.** In at least some cases, orders did not follow the time pattern market estimates indicated. Convair,



CUMULATIVE write-off system, in general followed by Boeing, Lockheed and Convair, produces an over-all breakeven point in this fashion. Note how write-offs and write-downs are spread over a relatively long period of time.



WRITE-OFF against a specific number of airplanes in Douglas practice concentrates charges in a shorter time period, shows full extent of costs sooner.



United Opens New Jet Engine Overhaul Center

United Air Lines' jet engine overhaul building at San Francisco will service engines for the company's DC-8 and Boeing 720 aircraft. At peak capacity the new center will be able to overhaul five jet engines per 16-hr. day in "assembly line" operation.

for example, found orders for its medium range jet did not materialize as fast as expected. Lockheed got fewer orders for Electras in 1959 than forecast.

As of the end of 1959, the breakdown of deliveries and charges against earnings for the five U.S. manufacturers building turbine transports:

	1959 Only	Total program
• Boeing.		
Airplanes delivered	73	82
Charges against earnings	$58,000,000	$152,000,000
• Convair.		
Airplanes delivered	none	(First delivery in 1960)
Charges against earnings	$43,097,476	$78,979,913
• Douglas.		
Airplanes delivered	16	16
Charges against earnings	$87,800,000	$236,700,000
• Fairchild.		
Airplanes delivered	41	63
Charges against earnings	000	$37,710,530
• Lockheed.		
Airplanes delivered	96	107
Charges against earnings	$16,044,000 (After Taxes)	$50,800,000 (After Taxes)

(Total deliveries through the first quarter 1960 are Boeing, 103; Convair, 1; Douglas, 40; Fairchild, 75, and Lockheed, 138.)

This total for all five to the end of 1959 is about $600 million before taxes. This should not be confused with total costs which are probably on the order of $1.5 billion for the same period. The $600 million figure represents research and development costs plus the loss on each airplane delivered—neither of which are covered by the sales price received for the airplane.

Qualified Loss

Use of the term "loss" must be qualified, since the ultimate goal is the recovery of these expenses over the full production run.

Though all companies follow the general accounting precept of not valuing inventory in excess of its sales price value—and this applies to any product—how this precept is applied varies enough to produce notable differences, as in the case of Douglas.

In general these expenses are broken down this way:

• **Inventory write-down.** Since pricing to the customer is based on volume production, early deliveries of production airplanes will be at a loss on an inventory basis alone. Thus the production cost of these early airplanes is written down to the realized sales price, and this difference between the actual sales price is referred to as inventory write-down. As the learning curve drops, sales price will begin to exceed inventory cost and later aircraft will be delivered at a profit on an inventory basis.

• **Research and development charges** that include all the initial engineering, prototypes in some cases, certification costs, and perhaps some tooling used in preproduction work. Generally referred to as write-offs, these are charged against income as incurred.

• **Inventory costs,** that is the actual charges in material and labor for building a production airplane, sales and administrative costs, plant overhead, etc.

Engineering Costs

Engineering costs may fall into R&D or inventory depending on company policy, or perhaps are divided into each by date when certification takes place.

Douglas has shown the most profound effect of these charges, though its 1959 over-all deficit of $33 million was also the result to some extent to declining military volume.

Douglas charges off all provisional losses against a selected group of initial

airplanes. In the case of the DC-8, the first 20 airplanes were projected originally to be loss aircraft, but this number was subsequently increased as costs rose to where it is now estimated at 70 (AW Apr. 25, p. 30).

Effect of the Douglas method is to concentrate the total in a narrower time span but also to produce airplanes showing a profit on an inventory basis sooner.

R&D Costs

Broken down for 1959, Douglas charged off $36.3 million for R&D and $51.5 million in inventory write-downs for the DC-8 for a total of $87.8 million. Total charges for the program through 1959 of $236.7 million breakdown into $157.2 million R&D and $79.5 million in inventory write-downs.

Douglas includes the cost of four experimental airplanes—the first of the four versions of the DC-8 (J57 and J75-powered domestic airplanes and J75 and Conway-powered overwater airplanes)—in R&D charges. Only tooling costs allocated to these four aircraft are included in R&D charges, but certification costs and certain indirect costs are also included.

Boeing and the other manufacturers to varying degrees follow a different practice in handling inventory write-downs which spreads them over a longer period of time in proportion to completion of total inventory costs.

In the case of Boeing, the policy is to base these write-downs on a block of airplanes, generally sold airplanes but with the exception permitted of including airplanes in production but unsold.

Boeing divides 707 costs into inventory and non-inventory, the latter corresponding generally to R&D costs. Non-inventory costs are those not contributing directly to the physical identity of the end item. Such costs would include certification flight tests, R&D on such items as reversers and suppressors and certain administrative and plant overhead costs. Unlike Douglas, Boeing would consider all tooling as directly contributing to inventory and make no distinction for experimental aircraft. Non-inventory costs are written off directly against earnings as incurred.

Inventory Charges

The inventory charges, where the most noticeable differences occur, can be shown using these hypothetical figures:

	Year-end
Sales price (total sold airplanes)	$600,000,000
Total costs	700,000,000
Project loss	$100,000,000
Non-inventory costs, written off as incurred	$80,000,000
Balance of write-off, total block	$20,000,000
Times percentage of completion of inventory costs of total sold quantity	50%
Cumulative inventory cost write-off	$10,000,000

Thus the annual report for the hypothetical year in question would show total commercial charges against earnings of $90 million, broken down into $80 million R&D and $10 million inventory write-down. These write-downs are computed as incurred and posted at each monthly book closing.

As more airplanes are sold, inventory write-downs are then recomputed, producing what becomes a write-down reversal. A table showing how this operates, and how it would be carried down to a profit and loss statement follows:

Costing base:	1958	1959	1960
	(in millions)		
Sales price value of sold airplanes	$500	$600	$800
Total inventory costs	530	620	780
Inventory Profit (Loss)	(30)	(20)	20
Per cent completion of inventory costs	60%	75%	100%
Cumulative inventory write-down	$18	$15	000
Annual Profit and Loss Effect:			
Sales	$40	$260	$500
Cost of sales	40	260	480
Gross earnings (Inventory profit)	....	....	$20
Inventory write-down	$18	....	....
Inventory write-down reversal	....	$3	$15
Earnings (loss) before taxes	($18)	$3	$35

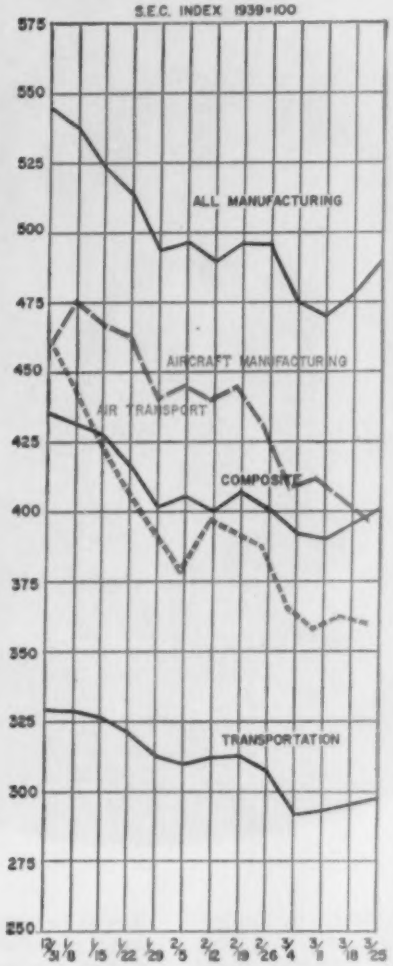
Profit and Loss

Thus in 1958, the inventory write-down in effect assumes there will be no more orders and the expected total loss of $30 million is written down proportionately (60% of $30 million or $18 million) against income. Sales and cost of sales in the profit and loss statement would represent deliveries and costs actually incurred for them. (If the profit and loss statement represented over-all company operations, this would mean a deficit for the year, but normally these charges would be covered by income from other sources.)

The following year, with more airplanes sold, a new inventory write-down is computed for the whole program totaling $20 million. On a proportional basis, this is $15 million. Since $18 million was charged off the year before and the new results show a total write-down of only $15 million, the company in effect recovers the difference, or $3 million.

By the third year, the program is showing a $20 million inventory profit and the inventory costs are 100% completed. On a delivery basis, the program is showing a $20 million profit. With the additional sales, and resulting inventory profit, the company now also recovers the remaining $15 million of its initial write-down and carries the total figure—$35 million—down to earnings.

Both the Boeing and Douglas methods may seem to resemble a bookkeeping checker game, but like all systems, are fundamentally designed to avoid counting unhatched chickens. The Douglas system is the more conservative in that it states total, not proportional, losses to be expected in the shortest practicable time, and takes into account more remote but not entirely impossible catastrophes such as wholesale cancellations. Some accountants, on the other hand, feel this unduly penalizes the stockholder by over-penalizing earnings



Aviation Stocks—1st Quarter

How aviation stocks—manufacturing and air transport—fared in the stock market during the first quarter of 1960 compared with transportation and industrial stocks generally is shown in this chart based on Securities and Exchange Commission figures. Composite category includes all classes of industry. Note steep decline of airlines stocks in January.

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Changing Sales Pattern

This unusually detailed breakdown shows the changing pattern of sales for Thompson Ramo Wooldridge since 1950. Rise of the electronic, missile and space category has been the steepest.

Date	Aircraft	Automotive	Electronics, Missile and Space	Total Including Unclassified Sales
1950	$50,973,000	$69,252,000		$123,313,000
1951	108,731,000	82,875,000	$400,000	194,899,000
1952	199,150,000	72,624,000	804,000	274,080,000
1953	240,569,000	82,311,000	1,823,000	326,466,000
1954	182,979,000	80,530,000	5,149,000	270,830,000
1955	170,770,000	108,735,000	13,828,000	295,907,000
1956	203,722,000	95,190,000	33,831,000	335,520,000
1957	248,214,000	97,838,000	64,220,000	412,609,000
1958	163,613,000	84,537,000	89,382,000	340,622,000
1959	132,979,000	109,672,000	167,153,000	417,749,000

one year with resulting over-recovery likely the next.

Convair differs from Boeing in that its inventory write-downs are made on the basis of reasonably estimated orders for its 880/600 aircraft though the proportional method is used. If estimates are borne out by events, this is the least painful method for company and stockholder. But Convair's annual report points out the difficulties of making such estimates and the competitive pressures existing in the market.

Fairchild's practices have undergone changes since the start of the F-27 program. Originally it charged off costs proportionally as Boeing does on the basis of orders. When Fairchild's management changed, the policy was changed to write-off losses in full, rather than in proportion to expenditures completed, and this added $9.5 million to F-27 write-offs that had already amounted to $19.5 million under the former system for the year.

No write-downs were made in 1959, since they were cleaned up the year before, but Fairchild has released 15 airplanes for production this year for which no firm orders are in hand. If orders do not materialize as expected, some further write-downs may be required this year.

Lockheed's practice presents still further variation in detail. To compute its inventory write-down it uses a total sales price based on firm orders in hand for the year in question.

During 1959, Lockheed had allocated the inventory costs of each Electra to delivered airplanes on the basis of a reasonable estimate of the orders expected to be on hand at year-end, which would eliminate write-down reversals as orders were received during the year.

After mid-year, Lockheed decided that no more orders were likely to be received and charged-off the total inventory loss it estimated would result on the basis of orders in hand, rather than waiting until year-end. This was done to avoid presenting stockholders with an unexpectedly large write-down that had not been indicated in any reports earlier in the year.

Some uncertainty in costs is implicit in all these methods since at any one time until the program is completed total costs are made up of known costs for work already completed and estimated costs to complete airplanes in various stages of production.

New versions and various degrees of tailoring obviously can upset the learning curve and as a result increase costs.

Boeing's Allen pointed out another complication stemming from this. Spread between recurring production cost and selling price is different for each Boeing 707 model. Effect of new orders on Boeing's earnings will vary with models. Breakeven points are different for each one.

Breakeven point can mean either break even on an inventory basis—which Allen said Boeing had reached—or on a total expense basis that none of the manufacturers have so far. Some programs, such as Boeing's Stratocruiser, never reach either.

Facing uncertainties in military sales and tough competition in very expensive transport programs, manufacturers are taking a restrained tone in comments on the future of commercial programs.

Financial Briefs

North American Aviation reported sales increased but profits declined during the first half of its 1960 fiscal year compared with last year. The six-month figures: 1960 sales, $497,993,360; 1959 sales, $476,742,614; 1960 profits, $11,626,000; 1959 profits, $13,240,000. Backlog as of Mar. 31 was $637,381,460 compared with $662,000,000 at the start of the fiscal year.

Cessna Aircraft first half sales increased 7% to $56,314,000, including a 30% increase in commercial aircraft sales to $30,609,000. Profits were $4,232,000 or $1.31 a share compared with $3,870,000 or $1.20 a share for the same period last year. Cessna President Dwane L. Wallace said reception of the new Model 210 had been "exceptional."

Second Heliport Planned for New York

New heliport to be built by the Port of New York Authority (AW Apr. 4, p. 134) on the East River just above the Battery will make possible direct helicopter service between downtown Manhattan and metropolitan area airports.

Chance Vought Aircraft, Missile Sales Drop; Improvement Seen

Dallas, Tex.—Sales of $62,557,198 and net income of $883,162, or 74 cents per share, were reported by Chance Vought Aircraft, Inc., for the quarter ended Mar. 31, compared with $66,295,732 and $1,506,023, or $1.24 per share, respectively for the same period last year.

Sales of aircraft, missiles, parts and services totaled $52,207,715 for the quarter, showing a decline of $14 million in scheduled deliveries of Crusader fighters from the same quarter a year ago. Vought Industries, Inc., the company's mobile homes subsidiary, showed sales for the quarter of $10,349,483. Severe winter weather in many of the mobile homes market areas has been responsible for curtailment of deliveries in this period. Orders and deliveries in April point to a normally improved second quarter for this operation, Chance Vought officials note.

Breakdown of divisional activities include these highlights:

• **Aeronautics Division** has been awarded several research contracts by Navy for anti-submarine warfare studies, covering a two-pronged approach to this field, including ascertainment of knowledge of the underwater world to better understand the problems, optimizing the current state of the art of equipment and techniques and development of a sonobuoy. The division expects that its sonobuoy will lead to a "good' production volume on this item and also plans to compete on other parts of the detection system tied to the sonobuoy.

• **Company's Research Division** is currently doing ASW nuclear magnetic resonance studies. Chance Vought is building the research operation to a high level, currently employing some 20 scientists in this division, and expects to acquire a director this year to head this work. New research laboratory is operating a 100-kw., 2-in.-diameter plasmatron.

• **Astronautics Division** has delivered all four Scout research rockets in the original contract and is expecting a letter of intent for further vehicles for approximately double the initial award. Division is optimistic that it will be named later this year to an assignment on the Boeing Dyna-Soar, covering the nose cone and crew portion of this vehicle. Astronautics also is studying acquisition of a new 10-ft.-diameter environmental test chamber, costing approximately $300,000, which would provide an atmospheric vacuum of 1/10,000th mm. of mercury and −320F temperature, to develop electronic equipment for use in orbiting vehicles.

• **Range Systems Division** operating with "several millions of dollars in contracts" is surveying the European market for application of its services. As of Apr. 15, this division's tracking service in Hawaii has received and reduced data covering 1,350 orbiting passes of the Discoverer VII satellite for National Aeronautics and Space Administration.

At Texas Instruments, sales for 1960 should range between $240 million and $250 million with net earnings between $17,750,000 and $18,750,000, stockholders were told in Dallas, by President P. E. Haggerty.

He indicated that this high level would be attained by the company despite signs that markets this year now do not appear to be as strong as had been forecast last year and at the beginning of 1960. Sales for 1959 totaled $193,213,000 and earnings were $14,143,000.

Sales for the first quarter of 1960 reached $56,198,000, an all-time high for this period, with earnings after taxes and payments on preferred dividends being $3,897,000, or 99 cents per share of common stock. This compares with sales of $42,731,000 and earnings of $2,983,000 for the same period last year, which included combined sales and earnings of Texas Instruments and Metals & Controls Corp., Attleboro, Mass., acquired in April, 1959. Texas Instruments' first quarter sales alone in 1959 totaled $29,993,000 and earnings after taxes of $2.4 million.

Acquisitions And Mergers

Electronic Energy Conversion Corp., New York, has acquired a majority stock interest (82%) in Behlman Engineering Co., Los Angeles, and its subsidiary, Custom Magnetics, Inc. H. L. Behlman will continue as president of the latter firms, according to Dr. Victor Wouk, president of Electronic Energy.

Varian Associates, Palo Alto, Calif., will acquire complete ownership of Semicon Associates through an exchange of common stock. Semicon will become part of Varian's Microwave Tube Group. Dr. O. G. Koppius, Semicon's founder, will continue as its chief executive officer.

Seaboard & Western Had 1959 Loss

New York—Seaboard and Western Airlines showed a net loss of $3,814,295 in 1959 because of a drop in transitory business as wet leases and charters and because of a tough competitive procurement climate in military airlift contracts.

Scheduled freight and mail revenues almost doubled during the year—rising from $5,270,171 to $10,301,440—which was noted as significant progress toward Seaboard's long range objectives by its president, Raymond A. Norden.

Revenue Decline

Total revenues declined, however, from $21,546,176 in 1958 to $19,947,260, and the net loss was a large increase over the 1958 deficit of $321,614. Operating expenses increased from $23,458,695 to $24,619,169.

Seaboard is technically in default on working capital and net worth requirements of certain bank loans and on some phases of contracts to purchase five Canadair CL-44s, but both the bank and manufacturer have indicated they plan no action now to attempt to force collections. Seaboard said it is discussing new financing and is optimistic about obtaining it.

Seaboard has deposited $2,354,256 in cash for the CL-44s and 5¾% notes totaling $4,045,591, due in monthly installments from June, 1961, to May, 1966. It failed to make an additional cash deposit of $200,507 due in July, 1959, for spare Rolls-Royce Tyne engines, and this remained unpaid as of mid-April.

This item, plus various secured and unsecured notes to banks and suppliers totaling $5,019,704, added to salaries and accounts payable, gave Seaboard year-end current liabilities of $8,380,417.

Since Seaboard's current assets totaled $3,230,519, this gave the airline a working capital deficit of $5,149,898 and created the need for new financing. Seaboard's net worth at the end of 1958 of $7,897,503 declined to $4,091,293 as the result of the $3 million operating net loss.

Credit insurance premiums on the CL-44 order of $835,650 were paid by Seaboard. They were listed as a deferred charge to be amortized over the five year term of equipment trust certificates to be issued in 1961 to pay the balance of the CL-44 purchase price. Cash payments of $2,575,843 will be due in 1961 on or before delivery of the aircraft, and the balance due of

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$17,123,803 will be covered by the equipment trust certificates.

Long term debt of the airline, primarily the 5¼% notes deposited for the CL-44 order, totaled $4,413,091. Added to the short term debt previously listed, Seaboard has a total debt of $9,432,795.

Transatlantic freight is growing at its fastest rate in history, Seaboard reported, and said the 22,804,000 ton miles it flew in 1959 represented a 70% increase for such traffic. For future improvement of its financial position, Seaboard is looking to:

- **Increase** of transatlantic freight business.
- **Increase** in carriage of U.S. and foreign mail. These revenues rose in 1959 to $3,063,382 from $987,727 the year before.
- **Turbine** economics producing a "breakthrough" in the cargo business.
- **Diversion** of MATS-carried cargo to commercial airlines. Seaboard pointed out that it carried 12 million lb. of commercial cargo last year while MATS carried 74 million lb. over Seaboard's certificated routes.

National Aviation Corp. Cuts Airline Holdings

New York—National Aviation Corp. reduced or eliminated holdings in virtually all of its airline common stock during the first quarter of 1960.

The closed end investment company pruned its manufacturing portfolio as well but not as severely and in a few cases—Grumman and Piper, for example—holdings were increased. General Dynamics was the only manufacturer eliminated.

Airline common stock holdings eliminated: Braniff, 15,000 shares; Delta, 12,500 shares, Northwest, 3,000 shares, and Pan American, 15,000 shares. In addition, American Airlines' holdings were cut from 50,000 shares to 25,000 and United Air Lines from 35,000 to 20,000.

This action is in line with a year-end statement issued by the company that was highly pessimistic on the future outlook for the airlines. However, the company showed over-all profits in its holdings of three of the four airlines at year end, and pure trading considerations may have played a part. The fund showed net income for the quarter of $121,818 compared with $113,970 a year ago.

The only airline increases were addition of 10,000 shares of New York Airways common and $108,000 of Pan American convertible debentures. Major reductions of manufacturers were 12,500 shares of Marquardt Corp., 7,000 shares each of Collins Radio and Lockheed and 5,000 shares of Douglas.

Airlines Report Officers' Compensation

Washington—Following is a list of airline officers' salaries, bonuses and indirect compensations, expenses and stock holding for the year ending Dec. 31, 1959, as reported to the Civil Aeronautics Board.

Continental Air Lines, Inc.—**R. F. Six**, president and director, $61,667 salary, $27,590 expenses and 5,250 shares of common stock; **H. L. Lawrence**, vice president and director, $28,613 salary, $2,309 expenses and 210 shares of common stock; **A. Damm**, vice president-finance, $18,477 salary, $1,290 expenses and no stock; **H. W. Bell, Jr.**, vice president-personnel, $14,280 salary, $3,495 expenses and 161 shares of common stock; **C. H. Calhoun**, vice president-engineering and maintenance, $19,647 salary, $1,977 expenses and 210 shares of common stock; **M. L. Davis**, vice president-sales, $17,833 salary, $2,042 expenses and no stock; **L. H. Dennis**, vice president- passenger service, $19,647 salary, $2,476 expenses and 945 shares of common stock; **S. O. Halberg**, vice president-public relations and advertising (left company May 15, 1959), $5,438 salary, $230 expenses and 1,155 shares of common stock.

O. R. Haueter, vice president-operations $26,333 salary, $3,743 expenses and 2,166 shares of common stock; **M. Kramer**, vice president-economic planning and sales, $5,441 expenses and 1,575 shares of common stock; **S. B. Redmond**, vice president-regulatory proceedings, $15,907 salary, $4,171 expenses and 1,243 shares of common stock; **J. A. Uhl**, vice president and director, $12,833 salary, $200 bonus and indirect compensation, $1,750 expenses and 5,375 shares of common stock; **C. F. Whelan**, vice president-economic planning and sales, $17,767 salary, $1,766 expenses and no stock; **H. H. Cady** assistant vice president and treasurer, $12,773 salary, $78 expenses and no stock.

F. G. Colnar, vice president and budget director, $11,340 salary, $3,086 expenses and 63 shares of common stock; **G. J. M. Kelly**, secretary, $11,041 salary, $1,109 expenses and 855 shares of common stock; **P. F. Kriethe, Jr.**, assistant secretary, $11,-903 salary, $621 expenses and 5 shares of common stock; **E. B. Ranes**, vice president-customer service, $14,430 salary, $3,663 expenses and no stock; **R. G. Schorling**, vice president-purchasing and property, $13,177 salary, $1,893 expenses and 168 shares of common stock; **D. R. Wilson**, vice president-operations, $15,893 salary, $2,009 expenses and no stock.

Following directors were paid bonuses and indirect compensation instead of direct salary; **L. H. Mueller**, board chairman, $400 bonus and indirect compensation, no expenses and 31,395 shares of common stock; **L. C. Ames**, $200 bonus and indirect compensation, $716 expenses and 12,000 shares of common stock; **A. O. Beckman**, $300 bonus and indirect compensation, no expenses and 420 shares of common stock; **S. G. Cooper**, $300 bonus and indirect compensation, $2,029 expenses and 2,625 shares of common stock; **F. L. Ehrman**, $300 bonus and indirect compensation, $2,468 expenses and 4,315 shares of common stock in name of others; **M. F. Hellman**, $400 bonus and indirect compensation, $600 expenses and 11,025 shares of common stock in name of others; **L. D. Henry**, $400 bonus and indirect compensation, $1,156 expenses and 200 shares of common stock; **J. G. Holland**, $400 bonus and indirect compensation, $65 expenses and 3,255 shares of common stock.

W. P. Paepcke, $200 bonus and indirect compensation, $29 expenses and 2,100 shares of common stock; **F. H. Ricketson, Jr.**, $500 bonus and indirect compensation, no expenses with 6,090 shares of common stock; **T. Roberts**, $100 bonus and indirect compensation, $379 expenses and 65,152 shares of common stock; **R. J. Smith**, $300 bonus and indirect compensation, $470 expenses and 5,225 shares of common stock; **R. Stewart**, $200 bonus and indirect compensation, $265 expenses, 105 shares of common stock and $30,000 worth of 5½% convertible debentures (debt securities).

Following firms were paid for services rendered during 1959: **Cooper, White and Cooper**, legal, $20,799.49; **Holland and Hart**, legal, $25,140.16; **Peat, Harwick and Mitchell**, audit and survey, $11,727.77; **J. Walter Thompson**, advertising, $1,473,-109.11; **Charles Butler and Associates**, consultants, $12,667.10; **Hoff, Canny, Bowen and Associates**, consultants, $7,544.37; **McKinsey & Co., Inc.**, consultants, $82,132.00; **Leasure, Scheurer & Carter**, legal, $34,-433.64; **Planning Research Corp.**, consultants, $10,859.24; **Cross, Murphy & Smith**, consultants, $17,810.10; **American Express Co.**, commissions, $16,500.84; **Boulder Travel Agency**, commissions, $6,151.94; **World Wide Travel System**, commissions, $9,916.50; **Travel Service Everywhere**, commissions, $11,958.15; **Grude Travel System**, commissions, $9,323.85; **Lones Travel**, commissions, $11,274.55; **MacDonald Travel**, commisions, $6,741.17; **Young and Rubicam**, commissions, $18,510.89; **Lennen & Newall, Inc.**, commissions, $14,221.44.

Trans World Airlines, Inc.—**W. L. Pierson**, chairman of the board of directors, $64,-821.90 salary, no bonus or indirect compensation, $9,037.76 expenses and 200 shares of common stock; **C. S. Thomas**, president and director, $64,821.90 salary, no bonus or indirect compensation, $26,428.52 expenses and 500 shares of stock; **E. O. Cocke**, senior vice president, system general manager and director, $44,765.34 salary, $5,000 bonus and indirect compensation, $8,605.95 expenses and 1,100 shares of common stock; **A. V. Leslie**, senior vice president-finance, treasurer and director, $44,761.17 salary, $4,000 bonus and indirect compensation, $5,047.23 expenses and 90 shares of common stock.

F. W. Ayers, Sr., director, $200 salary, no bonus or indirect compensation, $661.18 expenses and no stock; **P. Bradley**, director, $700 salary, no bonus or indirect compensation, $394.22 expenses and no stock; **J. A. Collings**, director, fees paid in accordance with senior consultants contract in 1959—$54,143.62. Expense borne by air carrier, $1,843.83, retired June 30, 1959.

R. A. Cook, director, $500 salary, no bonus or indirect compensation, expenses or stock; **O. Holcombe**, director, $500 salary, no bonus or indirect compensation, $818.92 expenses with no stock; **R. M. Holliday**, director, $100 salary, no bonus or indirect compensation, expenses or stock; **S. Maestre**, director, $1,000 salary, no bonus or indirect compensation, $527.17 expenses and 332 shares of common stock; **M. E. Montrose**, director, $500 salary, no bonus or indirect compensation, $729.49 expenses with no stock; **C. H. Price**, director, $500 salary, no bonus or indirect compensation, $1,253.23 with no stock.

H. E. Rogers, director, $400 salary, no bonus or indirect compensation, $1,203.69 expenses with no stock; **B.-F. Sessel**, director, $500 salary, no bonus or indirect compensation, $58.24 expenses with no stock; **A. D. Simpson**, director, $1,000 salary, no bonus or indirect compensation, $1,762.69 and 334 shares of common stock; **T. A. Slack**, director, $800 salary, no bonus or indirect compensation, $1,393.18 expenses with no stock; **M. H. West, Jr.**, director, $200 salary, no bonus or indirect compensation, expenses or stock; **L. Wright**, director, $700 salary, no bonus or indirect compensation, $270.94 expenses with no stock.

J. R. Barch, assistant vice president-industry sales affairs, $17,487.96 salary, $1,000 bonus and indirect compensation,

Canadian Navy Arms Banshees With Sidewinders

Royal Canadian Navy has armed McDonnell Banshee jet fighters with Philco Sidewinder air-to-air infrared heat-seeking missiles.

NASA announces . . .

THE TRANSFER OF THE DEVELOPMENT OPERATIONS DIVISION OF THE ARMY BALLISTIC MISSILE AGENCY TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. Wernher von Braun, director of the new NASA Marshall Space Flight Center in Huntsville, Ala., pictured with NASA's Mercury Astronauts

Dr. Wernher von Braun and his space team join NASA

The National Aeronautics and Space Administration leads the nation's efforts to find, interpret and understand the secrets of nature as they are revealed in the laboratory of space.

This vigorous effort requires boosters for space vehicles which greatly exceed the thrust of any boosters currently available. For this reason, the $100 million Huntsville plant, together with its famous space team, are being transferred to NASA. The new NASA facility in Huntsville will be known as the George C. Marshall Space Flight Center.

NASA is now the largest civilian research organization in the United States. For details about outstanding professional opportunities, address your inquiry to the Personnel Director of any of these NASA centers:

NASA Goddard Space Flight Center
Washington 25, D. C.

NASA Flight Research Center
Edwards, California

NASA George C. Marshall Space Flight Center
Huntsville, Alabama

NASA National Aeronautics and Space Administration

$2,525.04 expenses with no stock; **E. W. Barker,** assistant secretary, $15,796.96 salary, $500 bonus and indirect compensation, $178.10 expenses with no stock; **F. G. Betts,** vice president-purchasing, $24,668.98 salary, $1,000 bonus and indirect compensation, $1,004.40 expenses and 100 shares of common stock; **A. J. Brough,** assistant vice president-properties & facilities, (entered office Nov. 9, 1959) $3,020.57 salary, no bonus or indirect compensation, $842.98 expenses with no stock; **E. P. Burke,** assistant vice president and executive assistant to system general manager, $20,347.82 salary, $2,500 bonus and indirect compensation, $868.70 expenses and 30 shares of common stock.

F. E. Busch, vice president-equipment retirement, $30,915.04 salary, $1,000 bonus and indirect compensation, $5,529.51 expenses with no stock; **J. H. Ciemson,** vice president, $27,559.32 salary, no bonus or indirect compensation, $411 expenses with no stock; **P. G. Desautels,** vice president-national accounts, $24,931.66 salary, $1,000 bonus and indirect compensation, $4,648.75 expenses and 254 shares of common stock; **R. Duckworth,** corporate secretary, $17,939.30 salary, $1,000 bonus and indirect compensation, $3,323.20 expenses with no stock.

R. M. Dunn, vice president-technical services, $28,096.48 salary, $3,500 bonus and indirect compensation, $3,000.65 expenses with no stock; **H. D. Fellows,** assistant vice president-schedule planning and market research, $21,896.32 salary, $2,000 bonus and indirect compensation, $590.18 expenses with no stock; **C. S. Fullerton,** vice president-sales service, $26,404.61 salary, $2,500 bonus and indirect compensation, $6,291.93 expenses with no stock; **G. L. Gilmore,** vice president-public relations, $24,874.15 salary, $2,500 bonus and indirect compensation, $4,878.91 expenses and 270 shares of common stock.

J. I. Greenwald, assistant vice president-passenger service, $21,238.44 salary, $2,000 bonus and indirect compensation, $2,981.87 expenses with no stock; **F. D. Hall,** vice president and general transportation manager, $28,900.92 salary, $3,500 bonus and indirect compensation, $6,544.25 expenses with no stock; **J. D. Harrigan,** vice president-regional sales, $20,456.35 salary, $2,000 bonus and indirect compensation, $6,035.55 expenses with no stock; **S. L. Higginbottom,** assistant vice president-engineering flight test and inspection, $19,927.04 salary, $2,000 bonus and indirect compensation, $452.29 expenses with no stock; **A. E. Jordan,** assistant vice president-maintenance and engineering, $20,306.72 salary, $2,500 bonus and indirect compensation, $477.46 expenses with no stock.

J. W. Letzkus, vice president-regional sales, $27,424.49 salary, $1,750 bonus and indirect compensation, $14,367.03 expenses and 400 shares of common stock; **J. T. Logan,** assistant vice president-scheduling, $17,628.16 salary, $2,000 bonus and indirect compensation, $266.60 expenses and 2 shares of common stock; **L. P. Marechal,** vice president and general sales manager, $23,304.22 salary, $2,500 bonus and indirect compensation, $7,608.86 expenses with no stock; **J. N. Martin,** vice president-regional sales, $23,247.23 salary, $1,750 bonus and indirect compensation, $3,906.44 expenses with no stock.

R. Mazzarrini, vice president-international sales development, $23,224.47 salary, $1,300 bonus and indirect compensation, $6,896.62 expenses and 100 shares of common stock; **C. E. McCollum,** vice president, $19,267.30 salary, no bonus or indirect compensation, $647.91 expenses and 198 shares of stock; **J. P. Mead,** assistant vice president-industrial relations, $22,575.85 salary, $2,000 bonus and indirect compensation, $858.88 expenses with no stock; **B. E. Montgomery,** vice president-regional sales, $26,349.84 salary, $2,000 bonus and indirect compensation, $9,049.46 expenses with no stock; **R. B. Mueller,** assistant vice president-flight operations, $27,001.56 salary, $2,000 bonus and indirect compensation, $715.06 expenses with no stock.

W. E. Rooker, assistant treasurer, $20,365.96 salary, $1,250 bonus and indirect compensation, $300.78 expenses with no stock; **R. K. Rourke,** assistant vice president-equipment planning and development, $21,538.52 salary, $2,000 bonus and indirect compensation, $2,414.80 expenses with no stock; **R. W. Rummel,** vice president-planning and research, $28,002.47, $3,500 bonus and indirect compensation, $10,099.99 expenses with no stock; **T. K. Taylor,** vice president, $28,212.91 salary, $3,500 bonus and indirect compensation, $8,081.94 expenses and 36 shares of common stock; **J. W. Thomas,** vice president-civic affairs, $20,571.36 salary, $1,000 bonus and indirect compensation, $4,932.40 expenses with no stock; **W. L. Trimble,** vice president-regional transportation, $33,662.55 salary, $2,000 bonus and indirect compensation, $3,820 expenses with no stock.

Following firms were paid for services rendered during 1959: **Abbey Limousine,** limousine service, $8,050.35; **Airline De'ivery Service Co.,** messenger service, $7,919.28; **Airport Concessionaires, Inc.,** services at Los Angeles Ambassador Club, $6,664.23; **Louis R. Barbier,** transporting and establishing advertising displays, $8,672.28; **Beckel's Luggage Shop, Inc.,** luggage repairs, $7,601.25; **Bayden Associates, Inc.,** personnel specialists, $8,030; **Carry Transportation, Inc.,** limousine service, $45,962.83.

Chadbourne, Parke, Whiteside & Wolff, legal services and resident attorney's fees, $402,454.75; **Chemical Bank New York Trust Co.,** transfer agent for company stock, $11,507.97; **Chicago Non-Partisan Committee,** 1960 Republican National Convention, contribution, $5,000; **Coverdale & Colpitts,** financial forecast services, $37,924.28; **Cresap, McCormick & Paget,** management consultants, $252,223.12; **Ebasco Services, Inc.,** actuarial services, $11,421.

Employers Overload Co., clerical services, $22,960; **Foote, Cone & Belding,** advertising service charges and commissions, $72,789.22; **The Greater New York Fund, Inc.,** contribution, $5,650; **Haskins & Sells,** audit fees and professional services, $86,309.38; **Heart of America United Campaign,** annual contribution, $15,000; **Institute of Visual Training, Inc.,** service charge for booking, inspecting and shipping film, $22,110.73; **The Interstate Co.,** services at San Francisco Ambassador Club, $10,225.61; **Irving Trust Co.,** general administration and maintenance of trust securing loan, $8,021.86; **George A. Koteen Associates,** utility rate consultants, $7,202.56; **Los Angeles Host Committee,** contribution, $5,000; **National Travelers Aid Assn.,** contribution, $6,650; **Universal Agency, Inc.,** advertising services, $14,558.82; **Waters Arditto & Waters,** tax consultants, $5,500; **Wright, Wright, Goldwater & Wright,** legal services, $5,025.10.

Western Air Lines, Inc.—T. C. Drinkwater, president and director, $73,100 salary, $16,892 expenses and 6,432 shares of common stock; **S. R. Shatto,** vice president-operations and director, $45,600 salary, $1,289 expenses and 3,801 shares of common stock; **M. L. Landes,** vice president-service, $36,000 salary, $988 expenses and 1,600 shares of common stock; **A. F. Kelly,** vice president-sales, $36,000 salary, $5,502 expenses and 2,273 shares of common stock; **J. J. Taylor,** vice president and treasurer, $36,000 salary, $1,295 expenses and 2,455 shares of common stock; **D. F. Renda,** vice president-legal and secretary, $36,000 salary, $5,394 expenses and 1,019 shares of common stock; **S. Gewirtz,** vice president-administration, $31,667 salary, $11,459 expenses and no stock.

G. G. Brooder, vice president, $28,000 salary, $5,594 expenses and 1,396 shares of common stock; **C. J. J. Cox,** controller and assistant treasurer, $28,000 salary, $994 expenses and 1,337 shares of common stock; **W. C. Jennings,** assistant secretary, $15,367 salary, $205 expenses and no stock; **J. W. Simpson,** assistant secretary, $15,367 salary, $3,607 expenses and 25 shares of common stock.

Following firms were paid for services rendered during 1959: **Pogue & Neal,** legal, $11,762; **Darling, Shattuck & Edmonds,** legal, $12,582; **Killoran & Van Brunt,** legal, $15,318; **Gorgeson & Co.,** solicitation of proxies, $5,151; **Security First National Bank of Los Angeles,** transfer agents, $17,817; **United Givers Aid,** contribution, $6,000; **Burke, Kober & Nicolias,** architects, $6,939; **Clark L. Wilson,** market research, $15,504; **Peat, Marwick, Mitchell & Co.,** accounting, $12,571; **Judge Chuck Mau,** legal, $7,816.

PROBLEMATICAL RECREATIONS 12

Three men play a game with the understanding that the loser is to double the money of the other two. After three games, each has lost just once; and each has $24. How much did each have to start?

—Kansas State Engineer

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HUGHES ENGINEERING DIVISION
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I am interested in one of the following types of assignments:

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- ☐ DEVELOPMENT
- ☐ PROTOTYPE DESIGN
- ☐ ADVANCED TECHNICAL PLANNING
- ☐ SYSTEMS ANALYSIS
- ☐ SYSTEMS DESIGN
- ☐ OTHER:
- ☐ _____

I have had professional experience in the following specific areas:

- ☐ CIRCUIT ANALYSIS AND DESIGN
- ☐ DIGITAL COMPUTERS
- ☐ GUIDANCE DEVICES
- ☐ MICROWAVES
- ☐ STRESS ANALYSIS
- ☐ INDUSTRIAL DYNAMICS
- ☐ INFRARED
- ☐ SYSTEMS ANALYSIS
- ☐ R-F CIRCUITS
- ☐ RELIABILITY
- ☐ INERTIAL GUIDANCE
- ☐ INSTRUMENTATION
- ☐ ELECTRO-MECHANICAL DESIGN
- ☐ OTHER:
- ☐ _____
- ☐ _____

I have had a total of _____ years experience.

WHO'S WHERE

(Continued from page 23)

Changes

Jack Gilbert, supervisor-proposal engineering, United Aircraft Corp.'s Norden Division Laboratories Department, White Plains, N. Y.

Richard J. Kuri, national sales manager-printed circuits, U. S. Engineering Co., a division of Litton Industries, Van Nuys, Calif.

Robert B. MacKenzie, director of marketing, Sierra-Schroeder Controls Division, Idaho Maryland Mines Corp., Glendale, Calif.

Robert R. Pintar, in charge of the newly formed Research Group, Systems Division of Beckman Instruments, Inc., Anaheim, Calif.

Roy Smelt, chief scientist, Lockheed Missiles and Space Division, Sunnyvale, Calif. **Daniel J. Gribbon** succeeds Mr. Smelt as manager of the division's Satellite Systems organization. Other Satellite Systems appointments: **Don J. Murphy,** director of operations; **Fred O'Green,** assistant manager; **Bruno Augenstein,** scientific adviser to the manager; **Rogert W. Pearson,** head of modification and checkout and the Santa Cruz test base satellite operations.

Col. Ralph M. Jerome, appointed to the newly-created post of chief of staff for air, Minnesota Air National Guard, Duluth, Minn.

T. N. Duncan, manufacturing manager, Aero Hydraulics Division of Vickers, Inc., Detroit, Mich.

The Advanced Projects Laboratories, Hughes Aircraft Co., Culver City, Calif., has announced the appointment of the following laboratory managers: **Dr. R. L. Roderick,** ballistic missile and ballistic missile defense systems; **J. W. Ludwig,** space systems; **Leonard Mautner,** special systems; **R. K. Ausbourne,** tactical missile systems; **Dr. L. J. Money,** tactical aircraft systems.

Arthur S. Pawling, factory manager, and **E. R. Harrall,** director of product quality and reliability, Friez Instrument Division of Bendix Aviation Corp., Baltimore, Md.

Howard T. Sterling, chief engineer, Epsco Worcester (Mass.) Division of Epsco, Inc.

Peter L. Lindley, manager of technical services, Endevco Corp., Pasadena, Calif. Also: **John Haggerty,** special products engineer; **Howard C. Wheeler,** supervisor, calibration and test department.

Dr. Samuel B. Batdorf, manager of product planning, Range Systems Operations, Aeronutronic, a division of Ford Motor Co., Newport Beach, Calif. Also: **Richard T. Barrett,** manager of systems marketing, range systems operations and **Kenneth A. Dunn,** manager of administration.

Hugh Jacobson, manager, Systems Sales, Burbank (Calif.) Branch of Librascope Division of General Precision, Inc.

Jack H. Frailey, executive assistant to the general manager, Itek Corp., Boston, Mass.

Dr. Donald H. Garbaccio and **Dr. T. G. O. Berg** have joined the Technical Staff of National Engineering Science Co., Pasadena, Calif.

William A. Matthews, works manager, Kollsman Instrument Corp., Elmhurst, N. Y.

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- Missile Systems – Largest supplier of accessory power units, AiResearch is also working with hydraulic, hot gas and hydrogen systems for missiles, liquid and gas cryogenic valves and controls for ground support.
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The sales engineer we are looking for has had experience with hydraulic motors and pumps: He is the kind of a man who likes the challenge of introducing, and selling, a new line of hydraulic motors and pumps with outstanding design features. He will also broaden his knowledge to include high pressure pneumatics.

The sales engineering coordinator we are looking for is presently employed in a similar position. This person is needed to perform a valuable function. We encourage, and expect, this person to extend himself to responsible phases of sales planning.

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Mr. Kermit Reedstrom, Personnel Director,
The Cornelius Company, Aero Division,
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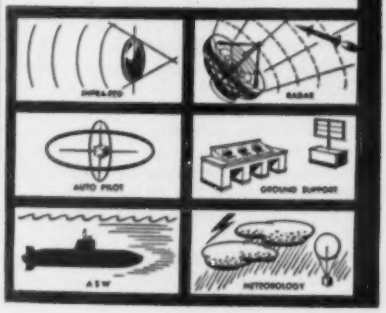

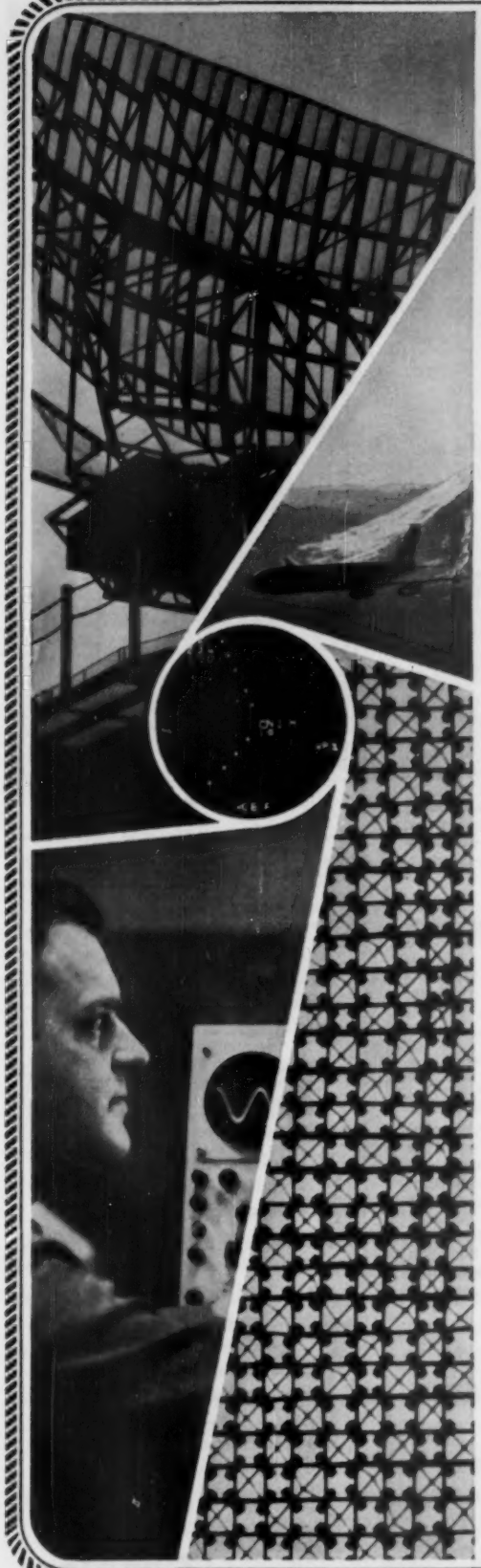

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COMPONENTS ENGINEERS—should be electronics men with emphasis on transistor circuitry. Will be responsible for designing components which go into the system. Must have circuitry design experience.

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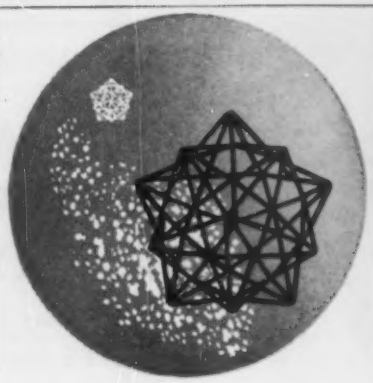

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P-4249, Aviation Week
520 N. Michigan Ave., Chicago 11, Ill.

LETTERS

Ike's Classmate

In a recent article re Thomas G. Lanphier, Jr. (AW Apr. 11, p. 127), you refer to Mr. Lanphier as "son of a West Point classmate of President Eisenhower."

The statement just quoted is incorrect. Lanphier, Sr., was in the West Point Class of 1914 and definitely not a classmate of the President. For your information President Eisenhower graduated in 1915.

In view of the foregoing, I respectfully request that you correct the error in an early issue.

I am writing to you since the Secretary, Class of 1915, United States Military Academy, is out of town.

E. De Treville Ellis
Col., U. S. Army (Ret.)
Asst. Sec., Class of 1915, U.S.M.A.

(Aviation Week *amends its statement to note that Thomas Lanphier, Sr., attended West Point three of the four years President Eisenhower was a cadet there.—Ed.)*

Pilot Age Limit

Both Mr. Bose, whose letter appeared in the Feb. 29 issue of Aviation Week (p. 102), and Mr. Hightower, whose letter appears in the Mar. 28 issue (p. 118), admit that they are not pilots and present no evidence that they have studied the available evidence concerning whether pilots at a given chronological age should be forceably retired. Mr. Bose and Mr. Hightower, therefore, present a view based on nothing but ignorance and its consort—prejudice. It is possible that pilots should be retired at a given age, but no evidence is at hand to indicate what age this should be.

Relatively few people have made a study of this question. Dr. Ross McFarland of Harvard is one of them. He concludes that an arbitrary age limit should not be set. I have seen no evidence presented, from a source more qualified than Dr. McFarland, refuting his conclusion.

Laymen such as Hightower and Bose imagine that physical attributes are the major needs of a safe pilot. The opposition says this is not so, that experience aloft is the one most vital factor. If this were not so, 20 year old pilots would be safer than 30 year olds and so on, for there is no doubt that physical capacities usually start deteriorating from the mid 20s on. Mr. Hightower has a perfect right to avoid flying with old pilots if he wishes, but he produces no evidence to indicate the pilot he does ride with will be as safe. He seems to take the position that his life is more valuable than the pilot's. If ALPA ever criticized the FAA for not instituting regulations before evidence existed to indicate the need, then ALPA was wrong. No restrictive regulation should be passed prior to evidence of need.

The senior pilots have been flying the most accident prone aircraft for many years and have an enviable record. That record should not be ignored without definite evidence to the contrary. I do not recall that ALPA's demands for higher pay were based on the need of "fast reflexes." The point is that there are physical and flight tests given frequently to determine the ability and reflexes of pilots of any age. To say that these tests cannot determine a below par pilot who is 60 years old or over is to say that these tests cannot determine a below par pilot who is 20, 30, 40 or 50 years old. If this is so, the tests are valueless.

The facts are that few pilots of 60 can pass these tests, but the few that do are safer pilots than most of the younger pilots. To arbitrarily discard these men reduces the over-all safety and is not in the public interest (although the public may believe it is). Mr. Hightower admits the railroads has enviable safety records, yet alleges that most railroad fatalities occur due to old engineers. There is no evidence that engineers over 60 are involved in any more fatal accidents than are younger engineers. The federal government does not impose an age limit on railroad engineers.

The only thing clear about the issue is that prejudice rather than facts has instigated the age limit. Laymen who have not made an honest attempt to study the problem have only ignorance and prejudice on which to base an opinion. I would like to ask either of these gentlemen if they have studied the evidence. Have they read the entire FAA presentation? Have they read the entire ALPA rebuttal? Have they read the work entitled "Human Factors in Air Transportation" by McFarland? Or the conclusions of Dr. Wayne Dennis? Or "A Survey of the Effects of Stress on the Performance of Pilots" by O'Kelly and Matheny? Or other similar studies?

It is unfair to come to conclusions without some study of the subject and both sides of a controversy, particularly when these opinions are to be published. Aviation Week has seen fit to publish these letters of Mr. Bose and Mr. Hightower supporting the age limit. From Aviation Week editorials on the subject is evident that Aviation Week also supports the age limit. In the interest of fair play, I expect to see either this letter or one taking a similar position published in Aviation Week. If you are unable to publish this letter, I would like you to forward the enclosed copies to Mr. Hightower and Mr. Bose as I do not have their addresses.

Ernest G. Marquis
Chief Pilot
Cluett, Peabody & Co., Inc.
White Plains, N. Y.

(Aviation Week *has taken no editorial position on airline pilot age limitation regulations. Letters published on this page represent the opinions of their authors, not of* Aviation Week.—*Ed.)*

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Third Party

In the "FAA Leadership" letter recently published (AW Apr. 11, p. 142), Capt. Richwine has afforded the followers of the long-standing government-airline debate some interesting reading and a few facts.

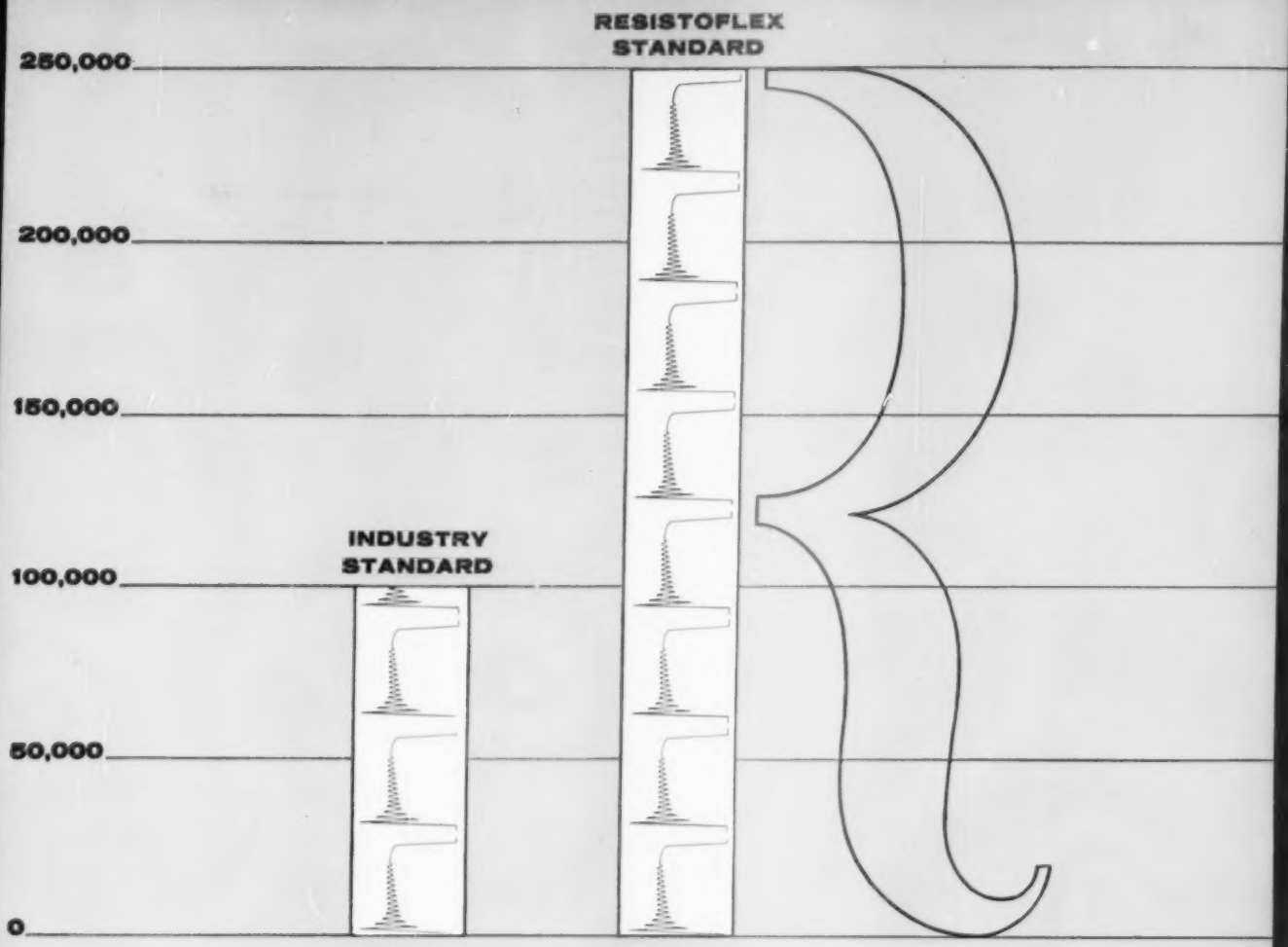
As on one other occasion, I would like to further interject the opinion of the third party: namely, those who sit in the seats of the airplanes flown by Capt. Richwine and regulated by Mr. Quesada. Grant at the outset that our participation for practical transportation purposes leads us to follow and observe the industry problems, and that we do in fact have enough collective intelligence to absorb and evaluate the professional problems at issue. Assuming this grant, I should like to comment on the captain's letter in direct reply.

Starting at the top, Mr. Quesada's efforts have not gone unrecognized by a cross-section of publications other than Aviation Week. The fact of the many governmental activities now directed toward commercial air travel cannot be construed in truth as having been originated solely to avert right now "one of the worst safety records in the history of commercial aviation," no more than Mr. Quesada can be implied as representative of the cause. As a point in case, could such government activity have ensured us two months ago against the current problems on that fine Electra airplane?

Agreed that the FAA has firmed up in its many testimonies a "hackneyed handful" of pilot inattentions, recognized by all concerned as to their frequency and impact on total safe flights accomplished as being almost not worth a second thought. This is understood by your own passengers as never happening with you and represents an FAA means to a valid end. We passengers know, Captain, when we are on your airplane that your feet are always on the rudder pedals and not the radar console. But if the FAA hadn't told you, would you know about the clown whose feet are not—and if you did, would you fly with him?

In summation, both FAA and ALPA have a fine record of capability and accomplishment. At this point in time, your passengers sincerely believe that today's ALPA man is the sharpest type that ever sat in a left or right hand seat, and we prove it to you every year by flying on your airplanes in increasing numbers. On the other hand, we clearly see Mr. Quesada furnishing us more insurance than we could ever buy at an airport counter, and a combination of these two confidence factors would be the ultimate that could be offered the people you are both striving to protect. This is a time for reasonableness, the one item that both your groups of mutual background seem to be ignoring. The current and impending jet age requires as much understanding on the ground as in the cockpit, and it would appear that Mr. Quesada should reference his instruments more often and Capt. Richwine should write fewer letters.

Edward T. Sherman
Elmhurst, N. Y.



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®Teflon is DuPont's trademark for TFE fluorocarbon resins.

ORIGINATORS OF FLUOROCARBON HOSE ASSEMBLIES

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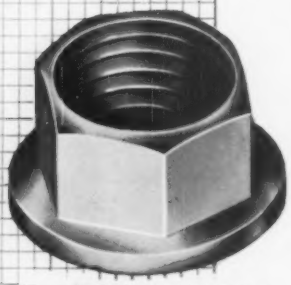
ESNA gives the design decision to the engineer

If your major consideration is . . .

. . . WEIGHT REDUCTION

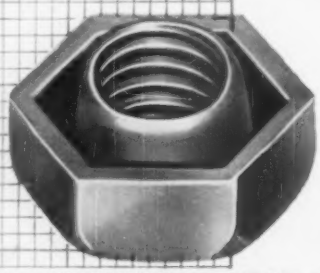


Type LH3324 (160,000 psi)
MS 21042

THIS NEW DESIGN is ESNA's recommendation for applications where space and weight reduction are primary needs. Meets MIL-N-25027; reduced wrenching dimensions permit more efficient centerline bolt design; wrench heights carefully engineered to assure satisfactory assembly line performance. Materials: carbon steel, AMS6304 alloy steel and A286 stainless steel.

wt in lbs per 1000	Screw Size # 4	# 6	# 8	# 10	¼"	⅜"	⅜"	tensile rating
LH3324	.2	.6	1.3	1.4	2.9	5.4	7.3	160,000 psi
NAS679	.9	1.7	2.4	2.6	4.6	6.4	8.6	140,000 psi
AN365	1.4	2.6	4.2	5.0	9.0	12.0	18.0	140,000 psi

. . . USE OF NAS STANDARD HARDWARE

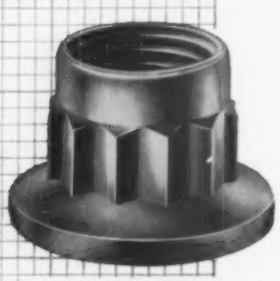


Type LHTE-TM (NAS 679 140,000 psi)

This complete line of low-height, lightweight NAS 679 hex nuts has been designed and produced to ESNA's exacting quality standards. Qualified to MIL-N-25027. External-internal wrenching surfaces for easy installation in limited access areas. Sizes 4-40 through 7/16-20. Alloy steel for temperatures to 550°F; A286 stainless steel for temperatures to 900°F and nonmagnetic applications.

ESNA offers a complete line of ALL NAS types of self-locking nuts, including standard and miniature anchors, floaters and gang channels.

. . . ULTRA-HIGH TENSILE AND FATIGUE PERFORMANCE



Type LH3393 (220,000 psi)

Specify types LH 3393 and LHEB 220 for the utmost in high tensile and fatigue-life performance. Highest strength-to-weight of any available double hex design. Cold-formed from alloy steels; sizes ¼-28 thru 1". For use at temperatures to 550°F.

Other lightweight 12 point nut series are available in several tensile capacities and materials for service at temperatures to 1300°F.

Fit the fastener to the application from the only complete line of self-locking fasteners

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. S36A-525, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

☐ Complete dimensional and performance data of the new type 3324 nut.

☐ Visual Index: A complete pictorial representation of all standard Elastic Stop nuts.

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